NOTES

ON THE

SAMPLES OF IRON ORE COLLECTED FOR ANALYSIS

AND

ON THE ORE DEPOSITS FROM WHICH THEY WERE TAKEN.

77

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN NORTHERN NEW ENGLAND.

By Edward R. Benton.

MAINE.

676,677,678. *Katahdin*, Piscataquis county. Limonite. One mile west of Katahdin iron-works, the works being about 50 miles north-northwest of Bangor and 19 miles north-northwest of Milo station, on the Bangor and Piscataquis railroad.

Mining was carried on here many years ago, but until 1873 only the ore occurring immediately on the surface (*i. e.*, not over 2 feet deep) was used. Since that time, when the works came under the management of O. W. Davis, jr., ore occurring 5 to 15 feet below the surface has been used.

The present workings consist of three excavations on the north side of a hill 1 mile west of the Katahdin iron-works. These excavations are 5 to 15 feet deep, and all show about the same character of deposit. Between the
c nearly east and west line connecting these excavations, and a road which runs 350 to 400 feet to the north of them, the ground has been to a great extent stripped of the overlying glacial drift, disclosing ore over an extent of 12 to 13 acres.

The excavations show several feet of glacial drift above, and below that irregularly alternating layers of two kinds of iron-bearing material, one the ore proper (hand-specimens 677, 677*a*, and 677*b*), the other a dark gray or bronze-colored material, consisting largely of sulphide of iron, and having a decomposed appearance (hand-specimens 677*c* and 677*d*). According to Mr. Colby, the chemist of the iron-works, the latter material contains 30 per cent. of sulphur. Piled in heaps it oxidizes rapidly, giving off sulphurous fumes, and depositing in the crevices fine crystals of sulphur and of sulphate of iron.

The layers of this material and of the ore are, in the main, conformable with the surface of the ground. The
d ore proper is a porous to cavernous limonite, showing mamillary, stalactite, and lamellar forms. It is said to contain before roasting about 4 per cent. of sulphur, but after being roasted in a Westmann kiln only 0.06 per cent.

The "surface" ore is limonite, and has in some places a basis of leaves and twigs, while in others it fills the interstices in the glacial gravel (hand-specimen 678).

The mine and furnace are managed by O. W. Davis, jr., and the ore is all used in the company's furnace.

677. Analysis: Iron, 46.00. Phosphorus, 0.009. Sulphur, 3.004. Phosphorus in 100 parts iron, 0.019. Sample taken from pile of raw ore at the furnace and from piles of ore ready for the furnace at the three excavations, 1 mile west of the furnace.

676. Analysis: Iron, 57.20. Phosphorus, 0.012. Phosphorus in 100 parts iron, 0.021. Sample taken from piles of roasted ore at the furnace.

678. Analysis: Iron, 47.28. Phosphorus, 0.037. Phosphorus in 100 parts iron, 0.078. Sample of "surface" ore taken near the three excavations, 1 mile west of the furnace.

Following is the complete analysis of No. 677:
e

	Per cent.		Per cent.
Sulphur	3.004	Potassa	0.12
Phosphorus	0.009	Soda	0.28
Iron, metallic	46.00	Carbonic acid	0.08
		Sulphuric acid	3.05
Silica	8.50	Phosphoric acid	0.020
Iron, protoxide	3.32	Titanic acid	.....
Iron, peroxide	59.95	Carbon in carbonaceous matter	0.27
Alumina	2.08	Hygroscopic water	3.86
Manganese, protoxide	0.02	Water of composition	11.46
Manganese, dioxide	.....	Total	100.120
Chromium, sesquioxide	0.10		
Lime	1.50	Per cent. of insoluble silicious matter	12.69
Magnesia	1.90	Silica	8.50
Iron, disulphide	3.270	Alumina	2.15
Zinc, sulphide	.....	Lime	0.58
Nickel, sulphide	0.13	Magnesia	1.51
Cobalt, sulphide	.....	Total	12.74
Copper, sulphide	0.06		

NEW HAMPSHIRE.

679. *Franconia*, Grafton county. Magnetite. Three miles southwest of Fraconia furnace, which is at Franconia village, 5 miles south of Littleton.

This mine and furnace have been in operation at various times since 1814. They were last operated in 1865. The deposit consists of a seam of magnetic ore imbedded in a chloritic schistose rock, and standing nearly vertical. The deposit occurs on the southwest side of a hill, and extends in a nearly northeast and southwest direction. The ore has been removed for a length of about 1,000 feet, and to a depth of at least 40 to 50 feet. Its thickness varies from 5 to 20 feet. The mine was inaccessible, so that the greatest depth reached could not be ascertained.

b More recent workings consist of a shaft at the southwest end of the old part of the mine. This shaft was said by Mr. Edson, who formerly had charge of the mine, to be 140 feet deep; it was long since abandoned. The furnace and mine are owned by Mr. Coffin, of Boston, Massachusetts.

679. Analysis: Iron, 49.01. Phosphorus, 0.188. Phosphorus in 100 parts iron, 0.384. Sample taken from piles of ore at the mine, and also from ore-piles at Franconia furnace.

VERMONT.

680. *Monkton*, Addison county. Limonite. One mile north of Caleb Rockwood's house, in Monkton.

c Not worked in the last twenty-five years. Nothing is to be seen of old workings except a pit filled with water, two piles of roasted ore covered with grass, and a few pieces of weathered ore lying about. The pit is about 250 feet long and 75 feet wide; depth unknown. It extends about east and west.

The ore was used about thirty years ago in a forge near Bristol, Vermont. It was mixed with ore from the west side of Lake Champlain.

680. Analysis: Iron, 42.05. Phosphorus, 0.223. Manganese, 0.65. Phosphorus in 100 parts iron, 0.530. Sample taken from a few pieces of weathered ore lying near the old excavation.

681. *Forestdale* or *Blake*. Rutland county. Limonite and hematite, manganiferous. Two miles east of Brandon village, at the Ocher works.

At this locality an iron mine was operated at least fifty years ago. No mining for iron has been done here for d many years, except for a short time two years ago. Several very old ore-pits are to be seen, and a more recent pit, 200 feet long and 60 feet wide, and filled with water. This pit, like all the more recent ones in the region, has been worked chiefly for ocher and umber for mineral paint. A little limonite (lump) is continually found, and raised with the ocher. Glacial drift is from 10 to 50 feet thick in this region.

The mine is operated to supply the ocher works of the Brandon Kaolin and Paint Company, of Brandon.

681. Analysis: Iron, 51.48. Phosphorus, 0.237. Phosphorus in 100 parts iron, 0.460. Sample taken from piles of several hundred tons of lump ore at the Brandon ocher-works.

682. *Brandon*, Rutland county. Limonite, manganiferous. Two miles northeast of Brandon village, near the ocher-works (not the works mentioned in connection with 681), and about a quarter of a mile north of the Forestdale or Blake mine.

e Many old shafts and pits are to be seen, but none are now operated for iron ore. These old shafts and pits extend north and south along the valley for half a mile, and over a width of several hundred feet; in most of them some iron ore was found. The shafts now working are operated for ocher, umber, and kaolin, but occasional bunches of iron ore are found and raised with the other material. Mr. Orum has charge of these ocher-works.

682. Analysis: Iron, 42.05. Phosphorus, 0.106. Manganese, 0.08. Phosphorus in 100 parts iron, 0.252. Sample taken from piles of lump-ore along roadside, taken from the ocher-shafts from time to time.

683. *Leicester*, Addison county. Limonite. Just north of Leicester ocher-works, and just east of Little or Hitchcock's pond, in the southern part of Leicester.

This mine consists of a large pit, about 30 feet deep, from which the ocher and umber are taken. A little f manganiferous limonite is found with it. The beds dip very slightly to the northwest. Mr. Brownson has charge of these works.

683. Analysis: Iron, 47.00. Phosphorus, 0.223. Manganese, 5.33. Phosphorus in 100 parts iron, 0.474. Sample taken from small piles of ore at the ocher-works which came from the pit described above.

684. *Granger* or *Pittsford*, Rutland county. Limonite. Close to Granger or Pittsford furnace (mouth of), eastern part of Pittsford.

Dilapidated pit and shaft from which the furnace was formerly supplied. Self-fluxing magnetite from Chateaugay, New York, is now exclusively used. Mr. Pritchard, furnace-manager.

684. Analysis: Iron, 45.80. Phosphorus, 0.268. Phosphorus in 100 parts iron, 0.585. Sample taken from small piles of greatly-weathered ore at old shaft just north of furnace.

685. *Godfrey*, Bennington county. Limonite. Two miles east of Bennington village on the railroad, close to the a eastern boundary of the town.

Two dilapidated shafts; depth unknown; no ore in place to be seen. Worked for iron four years ago. Owned by Burden, Troy, New York.

685. Analysis: Iron, 45.90. Phosphorus, 0.614. Phosphorus in 100 parts iron, 1.338. Samples taken from piles of ore at dilapidated washing-machine near shafts.

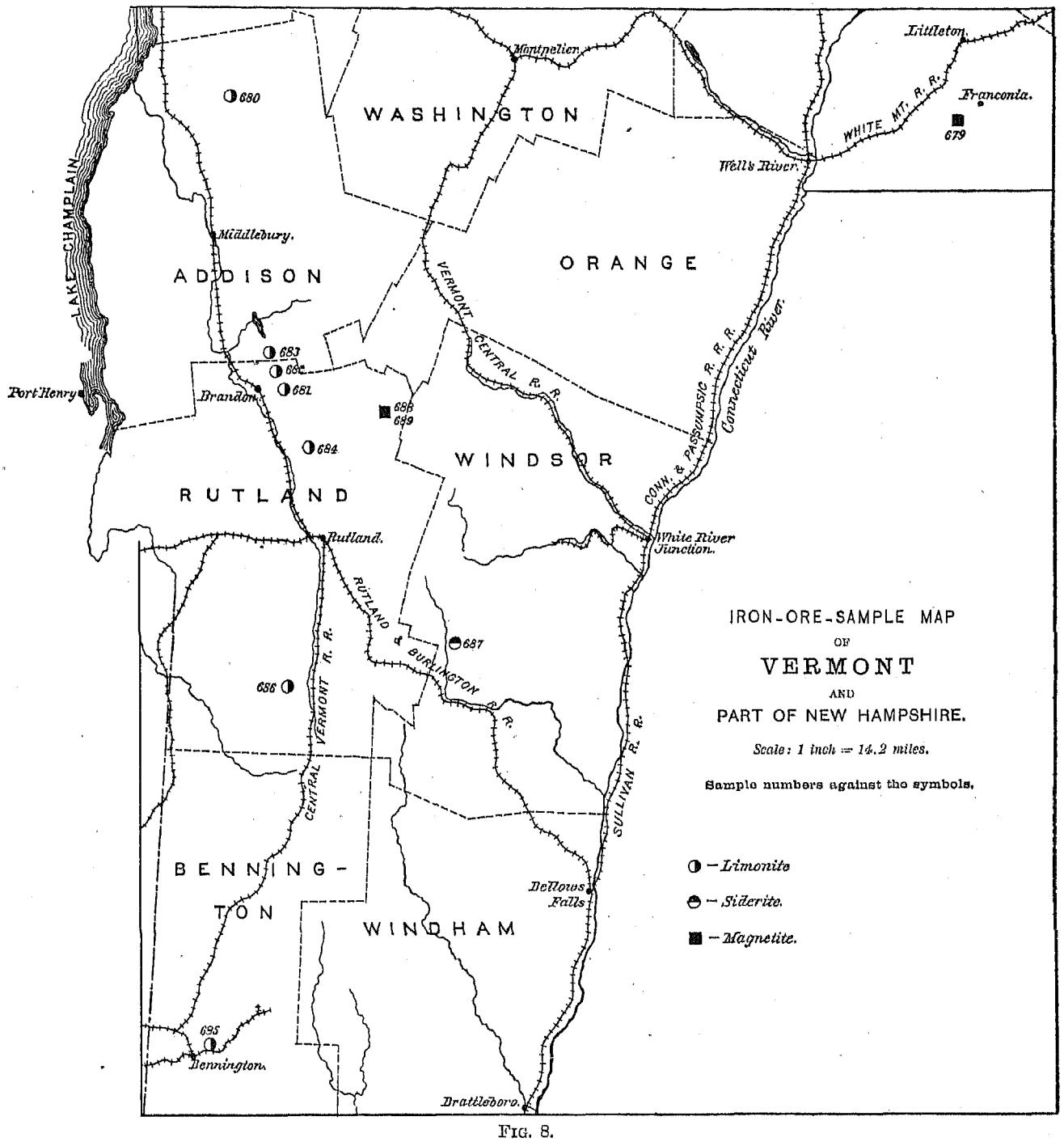


FIG. 8.

686. *Chipman*, Rutland county. Limonite. Seven hundred to 800 feet east of Bartlett Stafford's house, at the north end of Tinmouth pond, in the southeast part of Tinmouth.

A large number of old pits, but no ore in place to be seen. Ore formerly used in a furnace at Dorset, Vermont.

686. Analysis: Iron, 42.90. Phosphorus, 0.174. Phosphorus, in 100 parts iron, 0.406. Sample of weathered ore at old pits.

687. *Tyson furnace*, Windsor county. Siderite. On Mr. Davis's land, 1½ miles northeast of Tyson furnace, in the southeast part of Plymouth.

This ore occurs in the form of a seam in mica and chlorite schist. Its strike, like that of the foliation of the schists, is north 25° east. The dip is 50° to 70° east. The thickness is 6 to 10 feet, and the gangue is chlorite, biotite, quartz, and garnet.

a The workings consist of an open cut, perpendicular to the strike, to reach the seam, and then a cut along the seam both ways, the length of the latter cut being 75 feet and the depth 25 to 30 feet. The ore and gangue contain pyrite and chalcopyrite, and the iron formerly made from it in Tyson furnace is said to have been too brittle for use.

687. Analysis: Iron, 32.24. Phosphorus, 0.010. Phosphorus in 100 parts iron, 0.031. Sample taken from ore-piles at Tyson furnace and at the mine.

Following is the complete analysis of No. 687:

	Natural ore.		Natural ore.
	Per cent.		*Per cent.*
Sulphur	2.158	Sulphuric acid	0.15
Phosphorus	0.010	Phosphoric acid	0.023
Iron, metallic	32.24	Titanic acid	.....
		Carbon in carbonaceous matter	0.22
Silica	11.31	Hygroscopic water	0.08
Iron, protoxide	40.19	Water of composition	0.34
Iron, peroxide	.....	Total	100.00
Alumina	3.74		
Manganese, protoxide	2.56	Per cent. of insoluble silicious matter	13.28
Manganese, dioxide	.....	Silica	11.31
Lime	1.74	Alumina	1.37[a]
Magnesia	7.26	Lime	0.34
Iron, disulphide	3.747	Magnesia	0.10
Zinc, sulphide	Trace.	Potassa	0.00
Nickel, sulphide	0.24	Soda	0.16
Cobalt, sulphide	Trace.	Phosphoric acid	Trace.
Copper, sulphide	0.20	Titanic acid	.....
Potassa	.....	Total	13.34
Soda	.....		
Carbonic acid	28.20		

[a] With trace of oxide of iron.

688, 689. *Bethel* or *Pittsfield*, Rutland county. Magnetite. Two and a half miles west of Pittsfield village.

d The ore-bearing material at this locality is a ledge of metamorphic rock composed chiefly of quartz with some mica, and pervaded throughout with small crystals of magnetite. The rock is crushed and washed by steam-dressing machinery, and the crystals of magnetite readily separated.

No iron had been made from this ore, but near Bethel iron has been made from the magnetic sand of White river, which was probably derived from the same rock formation as that now worked at Pittsfield. Near the dressing-works forges for the making of steel by a patent process have already been begun.

688. Analysis: Iron, 10.10. Phosphorus, 0.146. Phosphorus in 100 parts iron, 1.446. Sample of rock from ledge at the dressing-works. Untreated.

689. Analysis: Iron, 65.82. Phosphorus, 0.026. Phosphorus in 100 parts iron, 0.040. Sample of magnetic grains, from the rock of the ledge at the dressing-works. Crushed and washed, ready for smelting.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN CONNECTICUT AND MASSACHUSETTS.

By BAYARD T. PUTNAM.

CONNECTICUT.

Magnetic ore occurs at several localities in the state,(*a*) but it has nowhere been found in sufficiently large quantities to pay for mining. Specular hematite is almost unknown. Spathic ore exists near Roxbury, Roxbury township, Litchfield county, and was mined in the early part of the last century. The mine was described by Mr. Shepard (*b*) in 1837, and at a later date a furnace was built at Roxbury to use the ore. But for several years past both mine and furnace have been idle. Limonite is at present the only ore of iron mined in Connecticut. The deposits now worked are in Kent and Salisbury townships, Litchfield county. In former years bog-ore was dug in the southeastern part of the state, but these beds have long since been abandoned. The beds of limonite have in general the same characteristics as those in Dutchess and Columbia counties, New York.

The *Kent* (17) (*c*) mine is located in Kent township, about 2 miles north of east from South Kent post-office. It is owned and worked by the Kent Iron Company, and the ore is all used in the company's furnace. Although an old mine (it was described by Mr. Shepard), it has not in recent years been extensively wrought, and previous to March, 1880, it had been idle for four years. No ore was raised in the census year. The ore lies between a decomposed micaceous gneiss on the west and a bluff of quartz rock on the east. The associated clay and ocher are similar in appearance to those usually found with the limonite. The workings are now all underground. There is one shaft 75 feet deep, and the ore is being exploited from four levels. Considerable rock-ore is obtained. Samples from piles of 100 tons of rock-ore and 300 tons of washed ore contained—

	No. 773.	No. 774.
	Per cent.	*Per cent.*
Metallic iron	53.02	50.48
Phosphorus	0.315	0.353
Phosphorus in 100 parts iron	0.594	0.699

Sample No. 773 is the rock-ore; sample No. 774 is the washed ore.

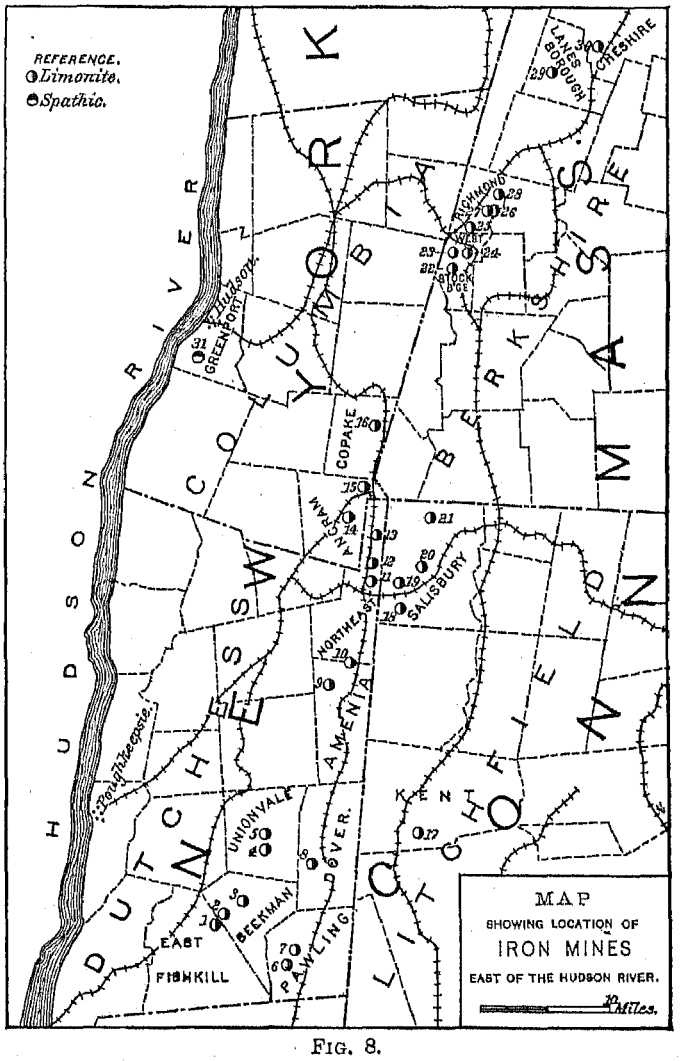


FIG. 8.

a See *Report on Geological Survey of Connecticut*, by C. U. Shepard, M. D., New Haven, 1837, p. 145.

b *Loc. cit.*, p. 30.

c The numbers refer to the map, Fig 8.

a Occurring in the ore-bed are masses or "horses" of an iron breccia, consisting of irregular angular pieces of limonite and quartz cemented together with limonite. Although usually too lean to be considered an ore of iron, a sample of it was collected and contained—

	No. 772.
	Per cent.
Metallic iron	30.82
Phosphorus	0.196
Phosphorus in 100 parts iron	0.636

b The *Chatfield* mine (18) near Ore Hill, Salisbury township, was opened in 1740. From 1868 to 1880 the mine produced 168,000 tons of ore. In the census year 11,200 tons were raised. The mine is worked by the Chatfield Mining Company. The ore is used in the neighboring charcoal furnaces. The pit is about 120 feet deep, and in some places the ore is covered with 60 feet of "stripping". Underground mining was begun on the north side of the pit in April, 1880. The workings are on three tracts of land (Fig. 9), and the ore from each tract is washed separately. A good opportunity was therefore presented to obtain samples from different parts of the same bed of ore. The samples collected **c** contained—

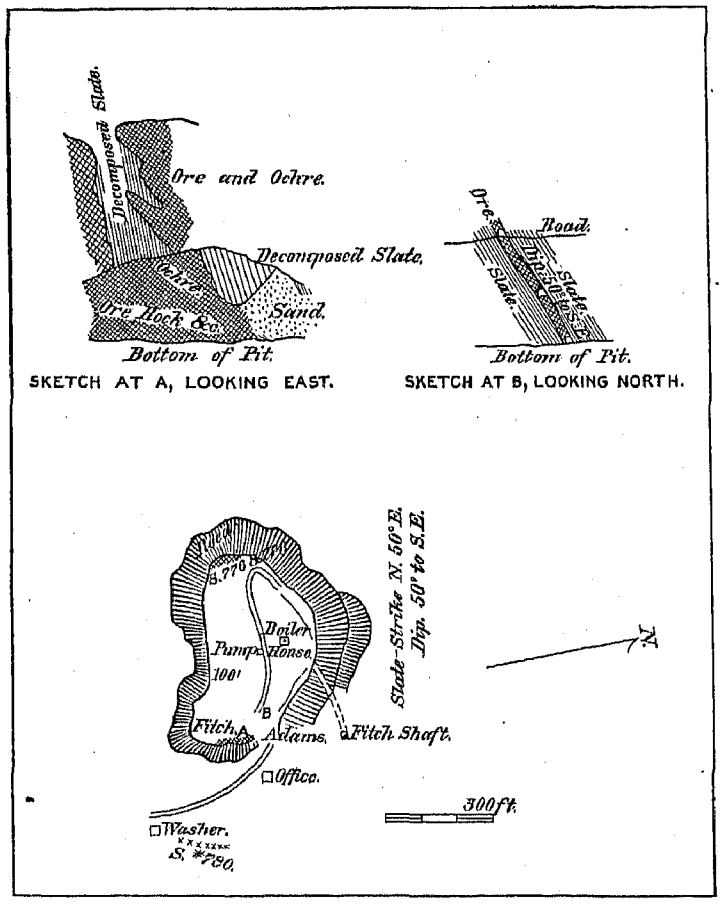


FIG. 9.—SKETCH OF THE CHATFIELD MINE, LITCHFIELD COUNTY.

NOTE.—The area represented by the "sketch at A" is about 10 by 10 feet. In the "sketch at B", the vertical distance between the road and the bottom of the pit is about 75 feet.

	No. 775.	No. 776.	No. 777.	No. 778. (a)	No. 779.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Metallic iron	35.10	40.03	44.04	44.38	48.02
Phosphorus	0.128	0.113	0.100	0.103	0.120
Phosphorus in 100 parts iron	0.364	0.282	0.227	0.232	0.250

a Contains manganese and baryta.

d Sample No. 775 is from 30 tons washed ore from bottom of tunnel, Adams' tract; sample No. 776 is from 40 tons washed ore from Reed's tract (west end of pit); sample No. 777 is from 45 tons washed ore from upper tunnel, Fitch's tract; sample No. 778 is from a few-tons rock-ore from Reed's tract; sample No. 779 is from a few tons rock-ore from Fitch's tract.

The ore is washed in a Bradford washer. A sample of the "slacks" was collected along the slack-stream from a point about 75 feet from the washer to **e** the washer. The sample contained—

	No. 780.
	Per cent.
Metallic iron	15.96
Phosphorus	0.071
Phosphorus in 100 parts iron	0.445

Where entered by the tunnels the ore lies in a narrow seam conformably between layers of partially decomposed slate. A noticeable movement or "fault" in the ore mass at the east end of the pit is indicated in the **f** "sketch at A".

The *Brookpit* or *Ore Hill* mine (19) is northwest of the Chatfield. The Connecticut Western railroad crosses one of the old pits. The mine was opened in 1731; in the census year 14,405 tons of ore were produced; the mine is worked by the Brookpit Mining Company. Ore Hill is completely covered with excavations, but when visited only one pit—called the New Pit—was being worked. No underground mining has been attempted, although the ore is covered with 30 to 40 feet of decomposed slate, clay, and gravel. The ore appears to be interbedded in the slate, as is shown in Fig. 10. Immediately above the ore the slate is so much decomposed as to require but little if any blasting, while still higher up the change into clay is complete. Many beautiful specimens of crystallized limonite have been found in this deposit. Samples consisting of selected chippings of two varieties of crystallized ore yielded on analysis—

	No. 781.	No. 782.
	Per cent.	*Per cent.*
Metallic iron	55.37	57.00
Phosphorus	.0.101	0.452
Phosphorus in 100 parts iron	0.182	0.793

Sample No. 781 represents a comparatively solid ore which has a fibrous structure and a silky luster. One surface of the specimen is jet black and is highly polished. The fibers are normal to this polished surface. Sample No. 782 consists of selected pieces of small stalactites. A transverse section of a stalactite shows it to have a radiated fibrous structure. The outer surface is smooth and highly polished. The stalactites are found in geodes or bombs and usually hang vertically. The great difference in the per cent. of phosphorus in the samples is noticeable. The samples were taken near each other in the deposit, and the two varieties appear to have been formed in the same manner, *i. e.*, through the solution of the iron oxide in surface-waters and recrystallization.

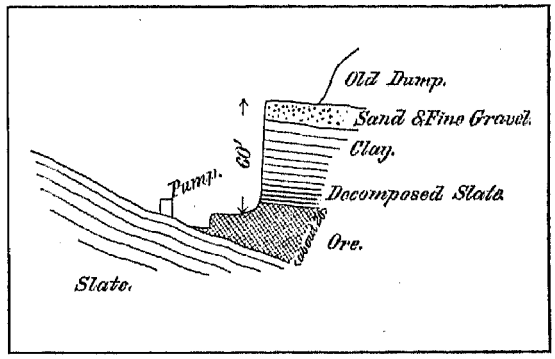


FIG. 10.—SKETCH SECTION AT ORE HILL, LITCHFIELD COUNTY, CONNECTICUT.

About one-half of the ore mined is rock-ore, and is shipped without treatment. Of the wash-ore one-half to one-third is lost in washing. Sample No. 783 is from 5 car-loads of rock-ore, and sample No. 784 is from 3 car-loads of washed ore. These samples contained—

	No. 783.	No. 784.
	Per cent.	*Per cent.*
Metallic iron	50.12	44.80
Phosphorus	0.196	0.162
Phosphorus in 100 parts iron	0.393	0.362

Following is the complete analysis of No. 783:

	Natural ore.		Natural ore.
	Per cent.		*Per cent.*
Sulphur	0.150	Phosphoric acid	0.450
Phosphorus	0.196	Carbon in carbonaceous matter	0.06
Iron, metallic	50.12	Hygroscopic water	0.81
		Water of composition	10.67
Silica	9.84	Total	100.020
Iron, protoxide	0.25		
Iron, peroxide	69.46	Per cent. of insoluble silicious matter	12.60
Alumina	3.65		
Manganese, protoxide	1.27	Silica	9.84
Lime	1.12	Alumina (with trace of oxide of iron)	2.01
Magnesia	0.80	Lime	0.14
Iron, disulphide	0.270	Magnesia	0.20
Potassa	0.69	Potassa	0.41
Soda	0.44	Total	12.60
Carbonic acid	0.14		
Sulphuric acid	0.04		

The *Porter* mine, at Lakeville, was not worked in the census year.

The *Davis* or *Forbes* mine (20), north of Lakeville, is owned by the Forbes Ore-Bed Company, and is operated by the Davis Digging Company. Ore was first dug here in 1732, the year after the opening of the Brookpit bed. In the census year 9,272 tons of ore were mined. Since 1867 the average annual yield has been about 9,000 tons. The ore is used by Barnum, Richardson & Co., the Lime Rock Iron Company, and the Hunts-Lyman Iron Company. Besides the ordinary limonite there occurs in this bed a manganiferous ore, and occasionally, also, pockets of black, earthy manganese. Samples taken of each variety yielded on analysis—

	No. 786.	No. 787.	No. 788.	No. 785.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	27.46	2.24	41.55	44.59
Metallic manganese	26.60	25.81	.....	.....
Phosphorus	0.045	0.068	0.073	0.059
Phosphorus in 100 parts iron	0.164	.....	0.176	0.132

a Sample No. 786 is from 15 tons of washed manganiferous ore; it is darker in color than the ordinary limonite, but in other respects resembles it. Sample No. 787 is from a pocket of black, earthy manganese in the pit. Sample No. 788 is from a few tons of the ordinary rock-ore, and sample No. 785 is from 20 tons of the ordinary washed ore.

The *Chapin* mine (21), 2 miles west of Chapinville, in the northern part of Salisbury township, and on lands of J. and N. E. Scoville, was opened some 80 years ago, and the ore was used to supply the old Chapin forge. The mine was reopened in December, 1879, and 140 tons of ore were raised in the census year. The pit is about 50 feet deep, and is entered by an adit 600 feet long. The ore lies between limestone and slate. A sample taken from 50 tons of rock-ore contained—

b

	No. 789.
	Per cent.
Metallic iron	54.47
Phosphorus	1.000
Phosphorus in 100 parts iron	1.836

The ore is very compact and heavy; its high contents in phosphorus is noticeable.

There are several other localities in Salisbury township where ore has been dug, but the foregoing are the only ones that have been worked for a number of years. The Indian Pond mine, too, in Sharon township, at one time supplied a large amount of ore, but it is now idle.

c

MASSACHUSETTS.

In Massachusetts, as in Connecticut, magnetic and specular ores have been found in small quantities only and are not commercially important. Carbonate of iron occurs associated with the limonite, and bog-ore is abundant in the central part of the state. But the only ore now mined is the limonite of Berkshire county. The occurrence of this ore here is similar to its occurrence in Connecticut and New York. It was formerly exploited in open pits, but during the past few years underground mining has been very generally resorted to.

The *Chauncey Leet* mine (22), owned and worked by the Hudson Iron Company, is located about 1¼ miles west of the village of West Stockbridge. It was opened in 1852, and it is estimated has produced a total of 504,000 tons of ore. In the census year 19,079 tons were raised. The ore is used at Hudson. The workings are entirely under-
d ground. There are two working shafts, and the lowest level is about 100 feet below the bottom of the old pit, or 140 feet below the original grass-line. The length of the workings is between 700 and 800 feet. Nearly the whole of the ore is washed. A sample from five car-loads contained—

	No. 790.
	Per cent.
Metallic iron	47.52
Phosphorus	0.187
Phosphorus in 100 parts iron	0.394

The *Nathaniel Leet* mine (23), owned by the Stockbridge Iron Company and worked by the Richmond Iron
e Company, is north of the Chauncey Leet. Ore was dug here before the Revolution. From January 1, 1870, to June 1, 1877, 81,715 tons of ore were mined. The shipments in the census year were 9,210 tons. The ore is used at Richmond, Van Deusenville, and Cheshire. The mine is worked both open-cut and underground. A sample from 50 tons of washed ore contained—

	No. 793.
	Per cent.
Metallic iron	46.65
Phosphorus	0.174
Phosphorus in 100 parts iron	0.373

f The *Goodrich* mine (24) lies east of the Nathaniel Leet mine. It was opened in 1875 and reopened in September, 1879. It is now worked by Lawrence Moffatt. The ore is used in the Pomeroy iron-works. In the census year 2,197 tons of ore were produced. The mine is worked entirely underground. There is one shaft 125 feet deep. At 108 feet from the surface the length of the workings is about 200 feet. Samples were collected from 100 tons of washed ore (No. 791), and from 30 tons of rock-ore (No. 792). The samples contained—

	No. 791.	No. 792.
	Per cent.	*Per cent.*
Metallic iron	40.71	46.87
Phosphorus	0.142	0.124
Phosphorus in 100 parts iron	0.348	0.264

The *Cone* mine (25) is in the southern part of Richmond township, half a mile east of the Richmond furnace. **a** The mine is a very old one. Until 1873 it was worked entirely open-cut, but now the greater part of the ore comes from the underground workings. The shaft is 208 feet deep. In the census year the mine produced 7,827 tons of ore. The mine is worked by the Richmond Iron Company. All the ore is used in the company's furnaces. A sample from a pile of 1,000 tons of washed ore contained—

	No. 794.
	Per cent.
Metallic iron	41.80
Phosphorus	0.102
Phosphorus in 100 parts iron	0.244

b

The *Cheever* mine (26), located about 2 miles northeast of the Richmond furnace, is owned by John H. Cheever, and is worked by the Richmond Iron Company. From June 1, 1871, to June 1, 1877, 33,482 tons of ore were mined. In the census year the production was 12,034 tons. The workings are principally underground. There are several shafts; the deepest of these is 160 feet. An exceptionally large amount of rock-ore is found in this deposit. Samples from 300 tons washed ore (No. 799) and 25 tons of rock-ore (No. 800) contained—

	No. 799.	No. 800.
	Per cent.	*Per cent.*
Metallic iron	45.82	43.82
Phosphorus	0.168	0.234
Phosphorus in 100 parts iron	0.367	0.534

c

The *Bank* mine (27) adjoins the Cheever on the west, and is on the same body of ore. It is owned and worked by the Stockbridge Iron Company. The ore is used at the Pomeroy iron-works. The mine was worked eight months in the census year, and produced 5,040 tons of ore. Samples were collected from the stock-pile at the Pomeroy furnace. These samples contained—

	No. 795.	No. 796.
	Per cent.	*Per cent.*
Metallic	39.12	50.48
Phosphorus	0.248	0.183
Phosphorus in 100 parts iron	0.634	0.363

d

Sample No. 795 represents the fine material in a pile of 2,000 tons of a mixture of rock and washed ore, and sample No. 796 the rock-ore in the same pile.

The *Bacon* mine (28), located at the western foot of mount Osceola, about 1½ miles northeast of the Cheever, is owned by Bacon & Andrews, and was reopened in April, 1880, by the Pomeroy Iron Company, after having been idle for a number of years. Before the close of the census year 280 tons of ore were raised. The mine was first **e** opened in 1846, and its total production of ore is estimated at 28,000 tons. The present workings consist of a shaft 50 feet deep, from the bottom of which drifts have been driven north and south 60 and 50 feet, respectively. The original workings were in an open cut, now filled with water. Samples of the ore from the stock-pile at the Pomeroy furnace, to which all the ore is sent, yielded on analysis—

	No. 797.	No. 798.
	Per cent.	*Per cent.*
Metallic iron	43.17	49.83
Phosphorus	0.999	1.249
Phosphorus in 100 parts iron	2.314	2.507

f

Sample No. 793 represents the fine ore in a pile of 300 tons of washed and rock ore, and sample No. 798 the rock-ore in the same pile.

Ore has been dug in many localities in Richmond township other than those above mentioned, but the beds referred to are the only ones recently worked. In Lanesborough township some ore was raised by its owner, J. L. Colby, from the Sherman mine (29), 2 miles west of the village of Lanesborough; and 1,367 tons of ore were raised in the census year from the Mason & Bliss mine (30) in Cheshire township. These mines were not sampled.

NOTES ON THE SAMPLES OF IRON ORE COLLECTED IN NEW YORK.

By Bayard T. Putnam.

The iron ores of New York may be conveniently grouped according to their mineralogical character and their geographical occurrence as follows:

I. Magnetite ores: (*A*) Of Orange and Putnam counties. (*B*) Of Washington, Essex, Clinton, Franklin, and Saint Lawrence counties.

II. Limonite ores: Of Richmond, Orange, Dutchess, and Columbia counties.

III. Carbonate ore: Of Columbia county.

IV. Fossil ores: Of Oneida and Wayne counties.

V. Hematite ore: Of Jefferson and Saint Lawrence counties.

On the accompanying map (Plate XXV) the localities where the different kinds of ore are mined are indicated by special symbols.

I. Magnetic ores.

A.—Orange and Putnam counties.

The belt of Archæan rocks extends northeastward from New Jersey into Orange and Rockland counties; thence crosses the Hudson river into Westchester and Putnam counties. On the northwest it is overlaid by Lower Silurian slates and limestones, and on the southeast, in Rockland county, it is covered by Triassic sandstone. The character of the belt is much the same as in New Jersey. The magnetic oxide of iron is widely distributed through the rocks, and has been mined in all the above-named counties. In the census year, however, no ore was produced in Rockland or in Westchester county.

The locations of the iron mines at present worked are shown on fig. 12.

Orange county.

Extending northward from the state line, in Warwick and Monroe townships, is a tract of 25,000 acres of land, a portion of a grant to Lord Sterling, which is now owned by the Sterling Iron and Railway Company. On this tract are the Crawford, Bering, Redback, Sterling, Lake, Tiptop, Scott, and other mines, and the Sterling and the Southfield furnaces. The Sterling Mountain railroad, owned by the company, connects the mines with the New York, Lake Erie and Western railroad.

The *Crawford* mine is in the southeastern part of Warwick township, about 1 mile from the state line. The mine was opened in 1792. In the census year it produced 2,240 tons of ore. The old workings extend along the side of the mountain, but are nowhere very deep. The vein is very irregular in width. The pit now worked is 40 feet deep, and the stope is about 15 feet wide. The ore is fine-grained and contains pyrite and apatite. A sample from a pile of 400 tons at the mine contained—

	No. 400.
	Per cent.
Metallic iron	57.66
Phosphorus	2.004
Sulphur	0.178
Manganese	Present.
Titanic acid	Present.
Phosphorus in 100 parts iron	3.476

The *Bering* mine, east of the Sterling furnace, produced 2,688 tons of ore in the census year. The ore was not sampled.

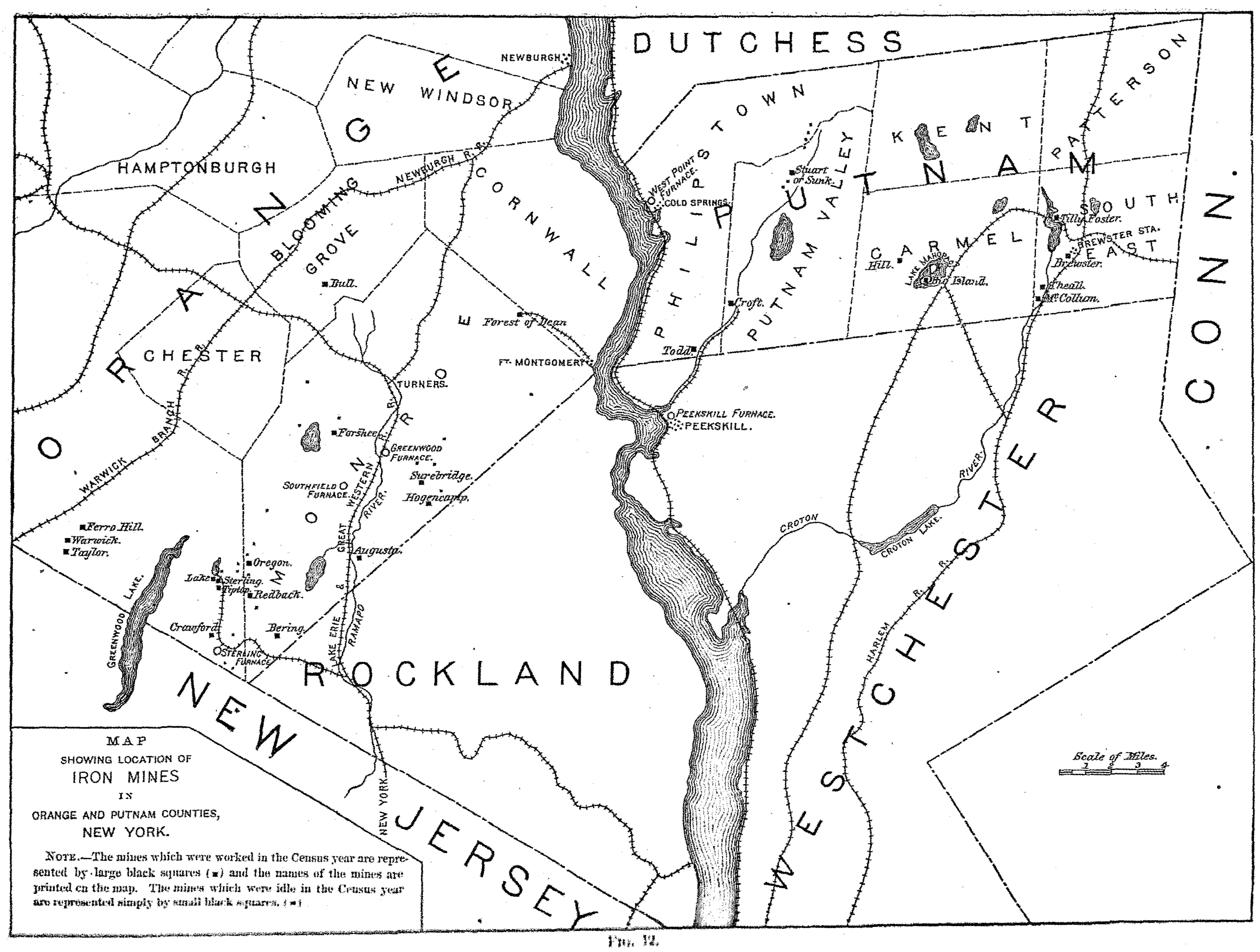

MAP
SHOWING LOCATION OF
IRON MINES
IN
ORANGE AND PUTNAM COUNTIES,
NEW YORK.
NOTE.—The mines which were worked in the Census year are represented by large black squares (■) and the names of the mines are printed on the map. The mines which were idle in the Census year are represented simply by small black squares. (▪)
DUTCHESS
ORANGE
PUTNAM
ROCKLAND
WESTCHESTER
NEW JERSEY
CONN.
NEW WINDSOR
HAMPTONBURGH
BLOOMING GROVE
CORNWALL
CHESTER
MONROE
PHILIPSTOWN
PUTNAM VALLEY
KENT
CARMEL
PATTERSON
SOUTH EAST
NEWBURGH
NEWBURGH R. R.
WARWICK BRANCH R. R.
WEST POINT FURNACE
COLD SPRINGS
FT. MONTGOMERY
TURNERS
PEEKSKILL FURNACE.
PEEKSKILL.
GREENWOOD FURNACE.
SOUTHFIELD FURNACE.
STERLING FURNACE
BREWSTER STA.
GREAT WESTERN R. R.
RIVER.
LAKE ERIE & RAMAPO
NEW YORK
CROTON RIVER.
CROTON LAKE.
HARLEM R. R.
GREENWOOD LAKE.
LAKE MAHOPAC
Bull.
Forest of Dean
Stuart or Sunk.
Croft.
Todd.
Hill.
Big Island.
Tilly Foster.
Brewster.
Theall.
McCollum.
Farshee.
Surebridge.
Hogencamp.
Augusta.
Ferro Hill.
Warwick.
Taylor.
Oregon.
Lake.
Sterling.
Tiptop.
Redback.
Crawford.
Bering.
Scale of Miles.
1 2 3 4

FIG. 12.

The *Redback*, or *Spruce Swamp*, mine is located on the top of Sterling mountain, about 3 miles from the Sterling furnace. It produced in the census year 3,638 tons of ore. Although an old mine (it was discovered in 1780), the ore contains so much pyrite that but little of it has been used until recently. Along the outcrop, owing to the oxidation of the pyrite, the ore is red in color, and this has given the mine its name. The mine is worked in open-cut, which is perhaps 20 feet deep. The vein dips at about 25° to the southeast. It varies in width, but averages perhaps 12 feet. The ore is teamed to the foot of the mountain, and is used at Sterling and at Southfield. A specimen of the unaltered ore contains a considerable quantity of green mica, besides pyrite and pyrrhotite. The magnetite is granular or in imperfect crystals, and has a bright metallic, sometimes splendent, luster. A sample taken from a few car-loads of the ore contained—

	No. 701.
	Per cent.
Metallic iron	52.93
Phosphorus	0.028
Sulphur	3.603
Phosphorus in 100 parts iron	0.053

The *Sterling* mine is the largest on the tract. It is situated near the south end of Sterling pond, about 2 miles north of Sterling furnace. It was discovered in 1750, and the following year a furnace was erected and put in operation near the mine. The ruins of the old stack can still be seen. In the census year the Sterling, Lake, and Tiptop mines together produced 26,173 tons of ore. The greater part of this amount was mined at the Sterling.

The sketch (Fig. 13) shows about the relative position of these three mines. It is here inserted, however, more to show the remarkable change in the direction of the strike and dip of the strata in the neighborhood of Sterling pond. The dip is indicated by the arrows. At the mine it is *toward* the north-northeast, and varies from 12° to 20°. According to Dr. Horton,(*a*) the "Sterling mine covers a surface of 30 acres by survey; part of this ore is bare, part of it is covered by soil 1 to 5 feet in depth, and part by rock 6 inches to a yard in thickness". All the ore from this immense outcrop has been removed, and the workings have been carried under a massive hanging wall or roof which is supported by pillars of ore. Along the northeast the ore has pinched down to a couple of feet or less in thickness. The direction of this pinch is northwest and southeast, and the workings have been carried along it. They have passed under the brook and are possibly now under the lake, or at all events not far from it. The ore varies in thickness from 10 to 25 or 30 feet, owing to the rolls in the walls. These rolls are well exposed in the old open workings where the ore has been taken entirely off the floor or foot-wall. The direction and pitch of their axes is toward the northwest. The rock near the ore is hornblendic gneiss and granite. Along the ridges of some of the rolls the gneiss is bent in a curve of a few feet radius.

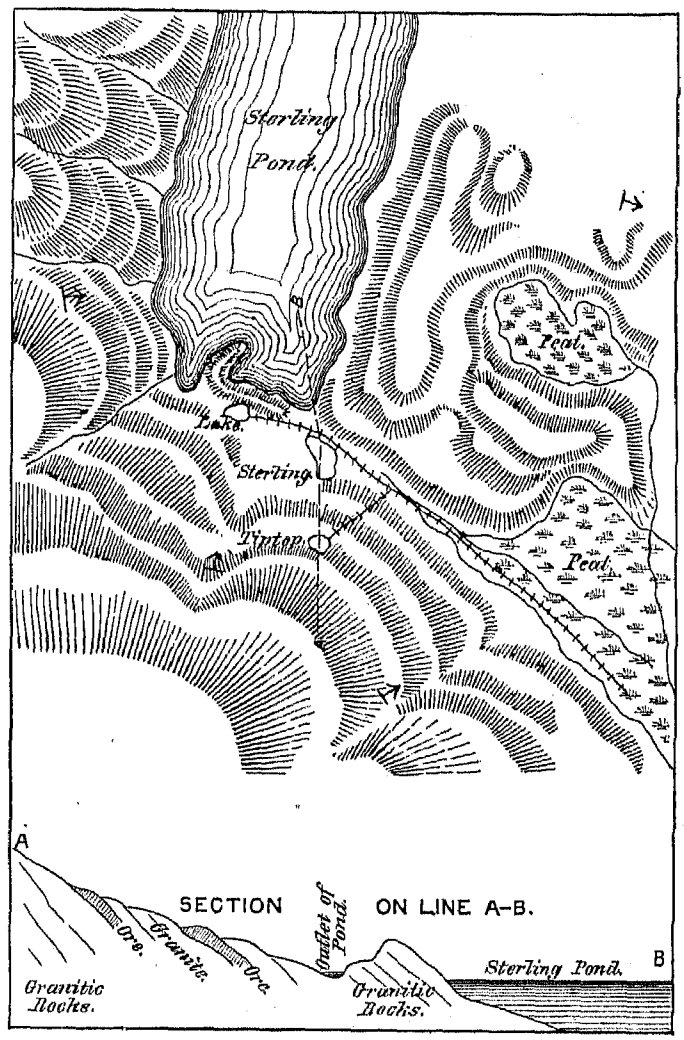


FIG. 13.—SKETCH OF THE STERLING IRON MINES AND VICINITY. Chiefly from *Geology First District of New York*, plate 30, figs. 4 and 5.

The greater part of the ore is a granular magnetite with more or less apatite; it is represented by sample No. 705, taken at the mine from a pile of about 250 tons. A separate sample (No. 706) was collected from a variety of ore, in which the magnetite is in large, tabular crystals, having a bright metallic luster. It contains a little hornblende and quartz, but is apparently almost pure magnetic oxide, and is a beautiful-looking ore. It lies in a narrow seam in the main mass. The samples contained—

	No. 705.	No. 706.
	Per cent.	*Per cent.*
Metallic iron	61.01	67.75
Sulphur	0.371	0.365
Phosphorus	0.284	0.145
Phosphorus in 100 parts iron	0.465	0.214

a Geology of the First District of New York, William G. Mather, p. 570.

a The *Lake* mine is west of the Sterling, on the same bed of ore. The underground workings of the two mines are estimated to be about 200 feet apart. Although under Sterling pond the mine is very dry. The ore resembles the Sterling ore. A sample from 50 tons of the ore on the cars contained—

	No. 704.
	Per cent.
Metallic iron	57.25
Sulphur	0.088
Phosphorus	1.205
Manganese	Present.
Phosphorus in 100 parts iron	2.105

b The *Tiptop* or *Summit* mine is on the hillside above the Sterling, and is on a vein of ore which appears to underlie the main vein, as is shown on the section (Fig. 13). The mine is a small one, and has been worked under the hanging-wall but a short distance. A tunnel through the hanging-wall at a level with the bottom of the mine enables the ore to be run out without the aid of machinery. The tram-cars are run to the bottom of the hill on a gravity incline, where the ore is dumped into pockets near the railroad. A sample of the ore from the cars contained—

	No. 702.
	Per cent.
Metallic iron	54.03
Sulphur	0.173
Phosphorus	1.751
Manganese	Present.
Titanic acid	Present.
Phosphorus in 100 parts iron	3.241

c

East and northeast of Sterling pond there are numerous old mines, but the only one recently worked is the *Scott* or *Oregon* mine, located in Monroe township, near the west township line, about 1 mile from the Sterling mine (or "Lakeville"). The strike of the vein is northeast and southwest, and the dip is at a steep angle toward the southeast. The ore is 5 to 6 feet wide. A portion of the ore is teamed directly to Southfield furnace (7 miles), and d the remainder is carted to Lakeville, whence it is shipped by rail. A sample of the ore from the cars contained—

	No. 703.
	Per cent.
Metallic iron	62.50
Sulphur	0.082
Phosphorus	0.711
Titanic acid	Present.
Manganese	Present.
Phosphorus in 100 parts iron	1.136

e The ore is finely granular, and has a schistose structure. It contains apatite. In the census year 5,783 tons of ore were mined.

Greenwood mines.—Of the several old mines east of the Greenwood furnace and owned by the Parrott Iron Company, the Hogencamp was alone worked to any extent in the census year. A little ore was, however, raised from the Pine Swamp, Greenwood, and Surebridge mines. The three mines produced 755 tons of ore, and of this 458 tons came from the Surebridge mine.

The *Hogencamp* mine is about 5 miles from the furnace by road. The vein has been worked to a depth of 60 feet and a length of 250 feet. The walls dip steeply to the northwest, and are very irregular. The ore averages 12 to 15 feet in width. A portion of the ore resembles sample No. 706, but it contains pyrrhotite and pyrite in quantities.. A sample from a pile of 100 tons contained—

	No. 707.
	Per cent.
Metallic iron	52.93
Sulphur	2.309
Phosphorus	0.033
Manganese	Present.
Phosphorus in 100 parts iron	0.062

The *Forshee* mine, sometimes called the "O'Neil" or "Nail" mine, is located a half mile southwest of the old O'Neil mine proper, and about 2½ miles due west of the Greenwood furnace. It was reopened in January, 1880,

and produced about 2,000 tons of ore before the end of June, when work was stopped. The mine is worked in a open-cut and a large amount of rock has to be moved, as the ore is in layers which alternate with layers of rock. The ore varies in texture; the magnetite is often in quite large grains, which have a more or less perfect octahedral form and splendent luster. Dr. Horton (*a*) found associated with the ore, red garnet, brown tremolite, green coccolite, serpentine (yellow and black), calcareous spar, asbestus, and mica. A sample from a pile of 75 tons of ore at the furnace contained—

	No. 708.
	Per cent.
Metallic iron	40.33
Phosphorus	0.020
Sulphur	0.453
Manganese	Present.
Phosphorus in 100 parts iron	0.050

b

The old *Clove* mine, about 2 miles northeast of the Forshee, was worked in the month of April, 1880, and about 15 tons of ore were mined. It was not visited.

The *Bull* mine is located about 2¾ miles north from the Clove mine, and 2 miles northeast from Oxford, in Blooming Grove township, on the top of Pedlar's hill. The upper portion of this hill is gneiss, surrounded on all sides by Lower Silurian slates. The mine is the most northerly one in Orange county. The ore lies in a shoot which pitches with the dip to the southeast at an angle of 25°. Its horizontal width is about 100 feet, its thickness 10 feet, and it is said to have been worked to a depth of 1,000 feet; but the deep part of the mine is now filled with c water. In the census year 2,579 tons of ore were raised. This was mined within 100 feet of the surface, principally from an old pillar. The total production of the mine is estimated at 52,000 tons. A sample of the ore from a pile of 100 tons at the furnace contained—

	No. 709.
	Per cent.
Metallic iron	51.30
Phosphorus	0.390
Sulphur	0.404
Titanic acid	Present.
Manganese	Present.
Phosphorus in 100 parts iron	0.760

d

The ore is very finely granular or compact in texture.

The Forshee, Clove, and Bull mines belong to the Parrott Iron Company, and the ore is all used in the Greenwood furnace, after being first roasted in heaps.

In the southern part of Warwick township, 2 or 3 miles south of the village of Warwick, and not far from the New Jersey state line, the Taylor, Warwick, and Ferro Hill mines are located, and were worked in the census year

The *Taylor* mine, belonging to Isaac Taylor, and operated by the owner, produced 896 tons of ore.

The *Ferro Hill* mine, owned by the estate of J. Mayir, L. Birdseye, *et al.*, and worked by M. Standish, produced e 353 tons of ore. Its total production is estimated at 4,000 tons.

The *Warwick* mine is owned and worked by the Parrott Iron Company. It produced 4,464 tons of ore in the census year. Its total production is estimated at 52,375 tons.

The above-named mines were not visited, but a sample was taken of the ore from the Warwick mine at Greenwood furnace. The vein is reported to be 4 to 5 feet wide and to have been worked to a depth of 185 feet. The ore contains much pyrrhotite. The sample yielded on partial analysis—

	No. 710.
	Per cent.
Metallic iron	52.35
Phosphorus	0.092
Sulphur	2.748
Phosphorus in 100 parts iron	0.175

The *Forest of Dean* mine is about 7 miles northeast of Greenwood furnace and 3½ miles northwest of Fort Montgomery, near the northeastern boundary line of Monroe township. It is owned and operated by the Forest of Dean Iron Ore Company. The ore is used in the Poughkeepsie Iron Company's furnaces, to which it is sent via tramroad to Fort Montgomery, thence by boat up the Hudson river. In the census year the mine produced 23,555

a Geology of First District, p. 573.

a tons of ore. The mine has been worked for many years, and its total production must have been large, but the figures were not obtained. The ore-mass is in the form of an immense shoot, which has the usual southeast dip and northeast pitch. The skiproad is laid on the "bottom rock" and is 1,200 feet long. The pump-shaft is about 900 feet northeast of the top of the slope; it is vertical and is 300 feet deep; hence the pitch of the chute of ore is one in three. An approximate section of the chute is shown in Fig. 14. The dimensions are estimated. Lines to indicate the stratification planes of the gneiss are purposely left out, as the relation of the ore-mass to the inclosing rock was not fully determined. The strike and dip of the ore was, at the surface, the same as the strike and dip of the gneiss; but the question is, is the "bottom rock" formed by a narrow synclinal fold? Such a fold appears to be a probable explanation of the peculiar shape of the ore-body. The mine

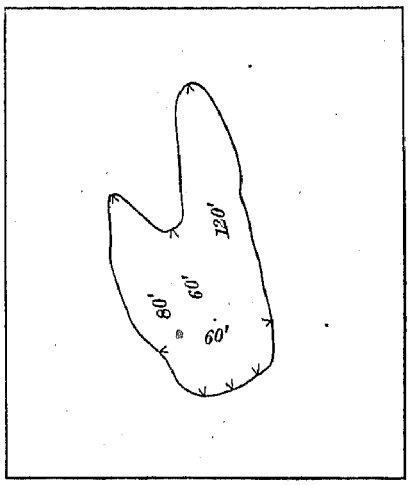


FIG. 14.

b was originally worked in open-cut. A section through the old pit is given by Professor Mather.(a) The mass of rock there marked "granite" is now seen to only partially divide the body of ore. Much of the ore is coarsely granular or "shotty", and it often contains white or flesh-colored calcite. Crystalline limestone occurs near the ore, but not in direct contact with it. A sample from a pile of about 2,000 tons of the ore at the mine contained—

c

	No. 711.
	Per cent.
Metallic iron	63.00
Phosphorus	0.621
Sulphur	0.148
Phosphorus in 100 parts iron	0.985

Iron ore has been mined at numerous other points along the Highlands west of the Hudson river, both in Orange and Rockland counties. The mines were small, however, and, with the exception of ore near Queensborough, have not recently been worked.

Two samples were collected at the West Point furnace (Coldspring) from piles of ore which had lain at the furnace for several years. These samples contained—

d

	No. 725.	No. 730.
	Per cent.	*Per cent.*
Metallic iron	39.03	44.47
Phosphorus	0.072	0.061
Phosphorus in 100 parts iron	0.180	0.137

The ore represented by sample No. 725 came from Stevens' mine, on Long mountain, near Fort Montgomery. That represented by sample No. 730 was shipped to the furnace from Verplanck point, Westchester county. But whether mined there or on the west side of the river is uncertain. When the sample was taken the superintendent of the furnace thought he could ascertain where the ore was mined, but this, he afterward wrote me, he was unable to do.

e

PUTNAM COUNTY.

The *Todd* mine is located in the southern part of Phillipstown township. It is owned and worked by the Fallkill Iron Company, and the ore is sent to the company's furnaces at Poughkeepsie via a narrow-gauge railroad to the Hudson river at Peekskill and thence by boat. During the census year 4,032 tons of ore were mined. The accompanying sketch (Fig. 15) shows the extent of the workings. Crystalline limestone forms the east wall of the main pit, and is seen outcropping to the *west* of the line between this pit and the "old opening", where it seems to have a direction at an angle with the strike of the ore. The old opening had caved in, but the superintendent of the mine assured me that considerable ore had been taken from it, and that a drift had been driven from one pit to the other through limestone. It was his belief that the limestone cut across the ore. A possible explanation of this

f is that there are here two shoots of ore, one near the upper part of the bed of limestone and one near the lower part of the same bed. At the tunnel, northeast of the main pit, the vein of ore is 3 to 4 feet wide. The sink is 25 to 30 feet below the surface. Very little ore has thus far been taken from this opening. Two samples of the ore were collected. They contained—

	No. 723.	No. 724.
	Per cent.	*Per cent.*
Metallic iron	44.34	47.58
Phosphorus	0.033	0.087
Phosphorus in 100 parts iron	0.074	0.183

a *Geology of First District*, Plate 5, Fig. 9.

Sample No. 723 is from 400 tons of the ore on the dock at Peekskill—all from the main pit. Sample No. 724 **a** is from a few tons of ore at the entrance to the tunnel. The ore contains calcite and a little pyrrhotite.

The *Croft* mine is northeast of the Todd, in Putnam Valley township. It is 9 miles by the railroad from the dock at Peekskill. The mine is owned by T. G. S. Flint and George C. Clark, and is operated by W. H. Campbell. It was reopened in 1880, after having been idle for five or six years. No ore was raised in the census year. The accompanying sketches (Fig. 16) were copied from the owners' plan of the mine, which was kindly loaned to me for the purpose. The ore averages 10 feet in width, and the work since the survey was made has removed it to a point below the "level of the proposed tunnel". The "Sketch at the end of the gangway, E", is **b** by Mr. Fulton. That portion of the mine was filled with water when visited by me, and the remarkable fold in the hanging-wall there figured was not seen. The mining operations were all in the "old workings" or "pit No. 1". A sample from a pile of 285 tons of the ore on the dock from this part of the mine raised several years since contained—

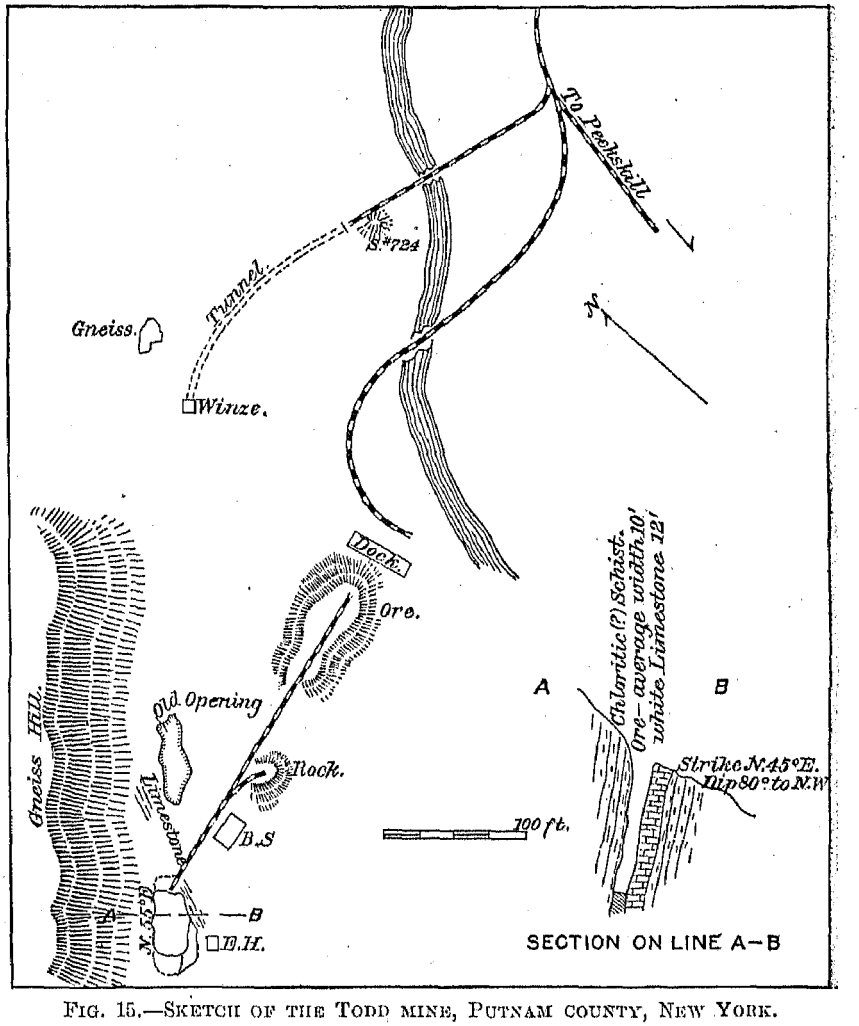


FIG. 15.—SKETCH OF THE TODD MINE, PUTNAM COUNTY, NEW YORK.

c

	No. 721.
	Per cent.
Metallic iron	60.83
Phosphorus	0.012
Phosphorus in 100 parts iron	0.020

A sample from 185 tons of ore from the top stope of the "new workings", or pit No. 2, called "No. 2 ore", contained—

d

	No. 721.
	Per cent.
Metallic iron	54.08
Phosphorus	0.066
Phosphorus in 100 parts iron	0.122

No. 2 ore differs from No. 1 in containing more quartz and pyrrhotite.

The following analyses were recently made for the company, and are here inserted for comparison: **e**

	No. 1.	No. 2.	No. 3.
	Per cent.	*Per cent.*	*Per cent.*
Magnetic oxide of iron	89.388	77.636	.....
Alumina	1.640	3.084	.....
Manganese	None.	None.	.....
Lime	0.355	0.660	.....
Magnesia	0.886	0.995	.....
Phosphoric acid	0.011	0.013	.....
Sulphur	1.047	2.018	.....
Silicious matter	6.650	16.335	.....
	99.986	100.741	.....
Metallic iron	64.720	56.210	64.06
Sulphur	1.047	2.018	1.14
Phosphorus	0.005	0.006	0.008
Silica	3.140	8.785	4.03
Phosphorus in 100 parts iron	0.007	0.010	0.012

f

Analyses Nos. 1 and 3 are of samples of ore from pit No. 1. Analysis No. 2 is of ore from the top stope in pit No. 2. Analyses Nos. 1 and 2 were made by Booth, Garrett, and Blair, May 6, 1880. Analyses No. 3 was made by the chemist of the Cambria Iron Company.

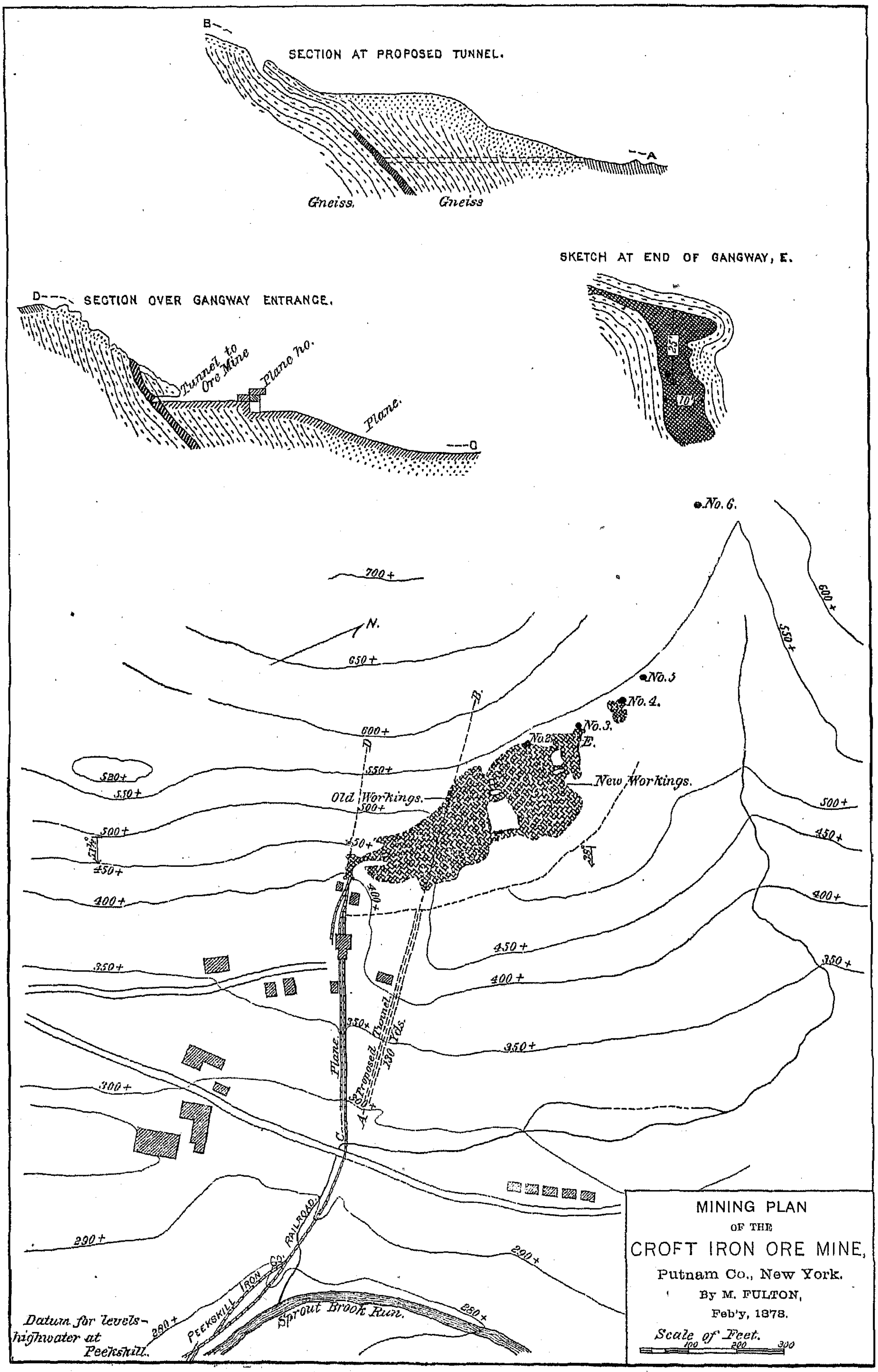

SECTION AT PROPOSED TUNNEL.
Gneiss.
Gneiss
SKETCH AT END OF GANGWAY, E.
SECTION OVER GANGWAY ENTRANCE.
Tunnel to Ore Mine
Plane no.
Plane.
No. 6.
700+
650+
600+
550+
500+
450+
400+
350+
300+
290+
280+
No. 5
No. 4.
No. 3.
No. 2
Old Workings.
New Workings.
Plane.
Proposed Tunnel.
130 Yds.
PEEKSKILL IRON CO. RAILROAD.
Sprout Brook Run.
Datum for levels-highwater at Peekskill.
MINING PLAN
OF THE
CROFT IRON ORE MINE,
Putnam Co., New York.
By M. FULTON,
Feb'y, 1878.
Scale of Feet.
100
200
300

FIG. 16.

In the northern part of Putnam Valley township numerous openings have been made along an outcrop of ore a which seems to be the extension of the Todd-Croft belt. On this belt the *Stuart* or *Sunk* mine is located on the east side of a mountain ridge, about 7 miles due east from Coldspring. The mine is owned by the Reading Iron Company. No ore has been mined for several years, but in the spring of 1880 the pumps were started and the mine was partly cleared of water; but owing to the financial embarrassment of the owners no active mining was done. The extent of the workings is shown on the sketch (Fig. 17). The dip of the ore is, as in the Todd mine,

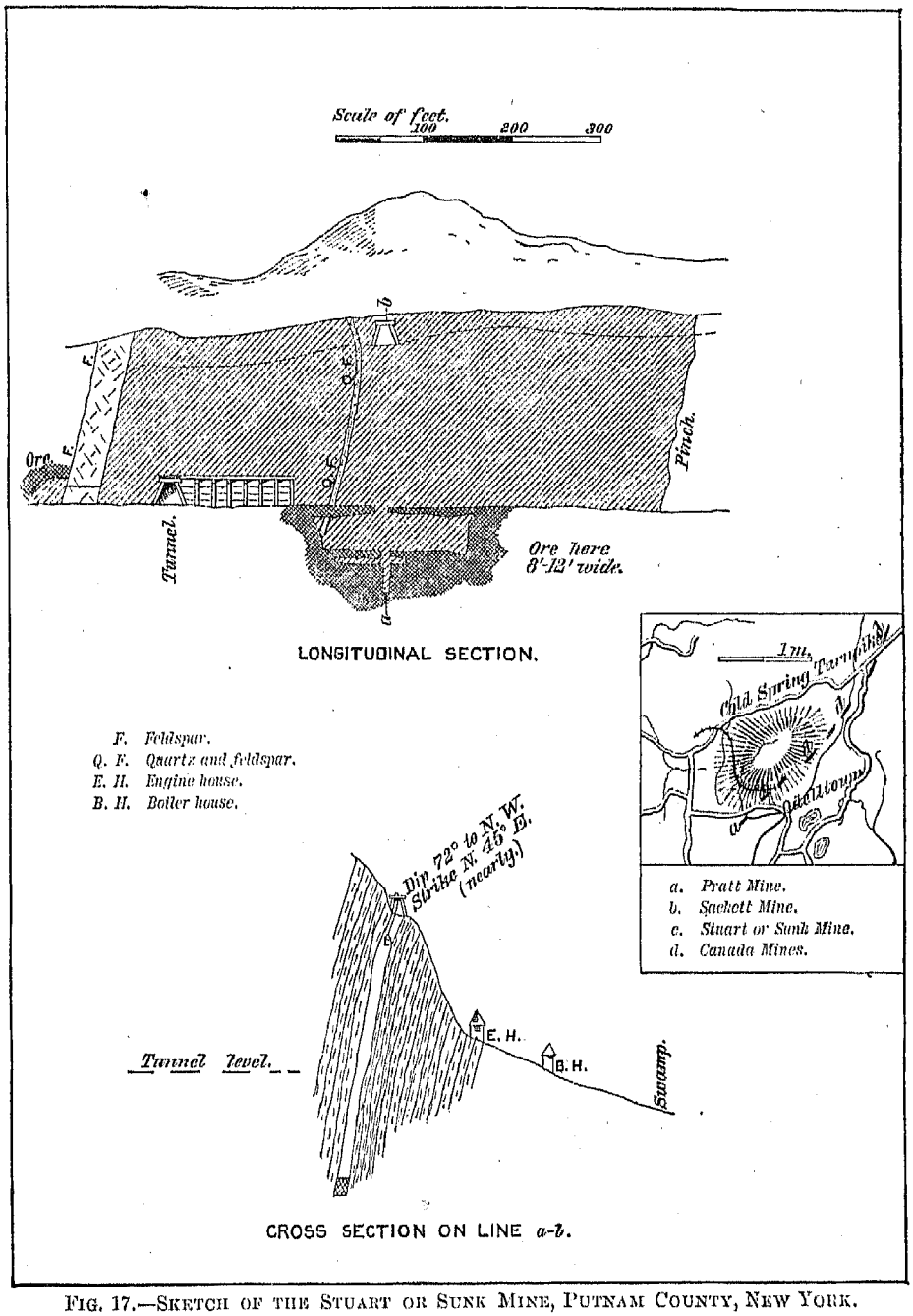


FIG. 17.—SKETCH OF THE STUART OR SUNK MINE, PUTNAM COUNTY, NEW YORK.

	No. 731.
	Per cent.
Metallic iron	57.23
Phosphorus	0.350
Titanic acid	Present.
Phosphorus in 100 parts iron	0.627

toward the northwest. At the tunnel-level the ore has been exploited for 700 feet. At the northeast end of the f workings it pinches down to a width of a few inches. At the southwest end it was entirely cut off by a "crossing" of feldspathic rock, but on drifting through this (about 50 feet) ore was found beyond. Only a little ore has been taken from this part of the mine, however. A sample of the ore was taken from a pile of 100 tons at the mine; the ore came from the sink. The sample contained—

a The *Pratt* and *Sackett* mines are southwest of the Stuart. The vein can readily be traced over the hill by the surface-workings. The shafts of the two mines are about 250 yards apart. The ore in the Pratt mine is reported to be 2 to 4 feet wide, and that in the Sackett mine about 5 feet wide. The Sackett shaft is about 75 feet deep. Some ore was raised from these pits eight years ago and teamed to the West Point furnace. A sample taken there *from a pile of 175 tons contained*—

	No. 726.
	Per cent.
Metallic iron	57.23
Phosphorus	0.663
Phosphorus in 100 parts iron	1.158

b

The *Denny* mine, situated southwest of the Pratt, and owned by the Parrott estate, was worked for a short time early in 1880 by the Thomas Iron Company. About 75 tons of ore were raised. The mine was not visited.

Northeast of the Stuart mine there is a long line of pits extending across the Cold Spring turnpike and known as the *Canada* mines. No ore has been raised from them for several years.

A sample was taken from a pile of 30 tons of ore at the West Point furnace, which came from the Rose mine, "on Peter Gilrichie's farm near Foshay corners, Kent township." The opening is reported to be 150 feet long and 10 feet deep, and the ore is said to be 5 feet wide. No work has been done at the locality for twenty years. The sample contained—

c

	No. 727.
	Per cent.
Metallic iron	51.90
Phosphorus	0.064
Manganese	Present.
Phosphorus in 100 parts iron	0.123

Early in May, 1880, the Lake Mahopac Iron Company began active explorations near German Flats, Carmel township, 1½ miles north of Red Mills. The locality is designated the *Hill* mine on the map (Fig. 12). The extent of the developments in the middle of August is shown in Fig. 18.(*a*) In the open cut no hanging-wall rock has been d encountered. The foot-wall is gneiss. From this pit about 2,000 tons of ore have been raised. Shaft No. 1, 240 feet northeast of the cut, is 110 feet deep. About 100 tons of ore have been taken from it, but the vein is narrow, and a drift is being driven westward in search of something better. No good ore has yet been met with in shaft No. 2. A little "mixed" ore was, however, brought up in the last few bucket-loads. The ore from the open pit is of excellent quality, as is shown by the following analysis of a sample taken to represent an average of a pile of 2,000 tons:

	No. 732.
	Per cent.
Metallic iron	61.87
Phosphorus	0.010
Phosphorus in 100 parts iron	0.016

e

The ore contains but little, if any, pyrite.

---

a In a paper entitled "The Iron Mines of Putnam County, New York", read at a meeting of the American Institute of Mining Engineers in September, 1884, Mr. Arthur F. Wendt states that an immense body of ore has been developed on this property. The shipments of ore had then amounted to 60,000 tons. A railroad was completed to the mine, and it was believed that the output in the future would be largely increased. "The mine practically assumes the shape of four beds of clean ore, from 10 to 50 feet wide, superimposed the one upon the other. Practically all the rock remains under ground and admirably answers the purpose of pillars." The horizontal section of the ore-body, or lens, is figured as roughly oval, the greatest width, at right-angles with the strike, being nearly 200 feet, inclusive, of course, of the interstratified rock. An "average analysis of samples just taken from 12,000 tons of ore, by Andrew S. McCreath", shows—

f

Sesquioxide of iron	52.018	Hygroscopic moisture	0.048
Protoxide of iron	22.885	Combined water	0.758
Bisulphide of iron	0.026	Silica	8.780
Protoxide of manganese	0.186	Alkalies and fluorine	0.427
Oxide of copper	None.	Total	100.000
Alumina	3.078		
Lime	1.450	Equivalent to—	
Magnesia	10.065	Metallic iron	54.225
Titanic acid	Trace.	Metallic manganese	0.144
Carbonic acid	0.251	Sulphur	0.014
Sulphuric acid	None.	Phosphorus	0.012
Phosphoric acid	0.028	Phosphorus in 100 parts iron	0.022

The ore is seen to resemble that from the Tilly Foster mine, in containing much magnesia and only trifling amounts of phosphorus and sulphur.

On Grand or Blackberry island, the larger of the two islands in Lake Mahopac, there is a vein of magnetic ore which is reported to have been worked many years ago to supply a neighboring forge. It now belongs to Richard George, of Dover, New Jersey, and was worked for a few months in the census year, producing about 900 tons of ore. The greater part of this amount probably came from a pit 30 feet deep, 15 to 18 feet wide, and 20 feet long, near the southeastern side of the island. Northeast of this opening some ore was taken out from an open cut 3 to 4 feet

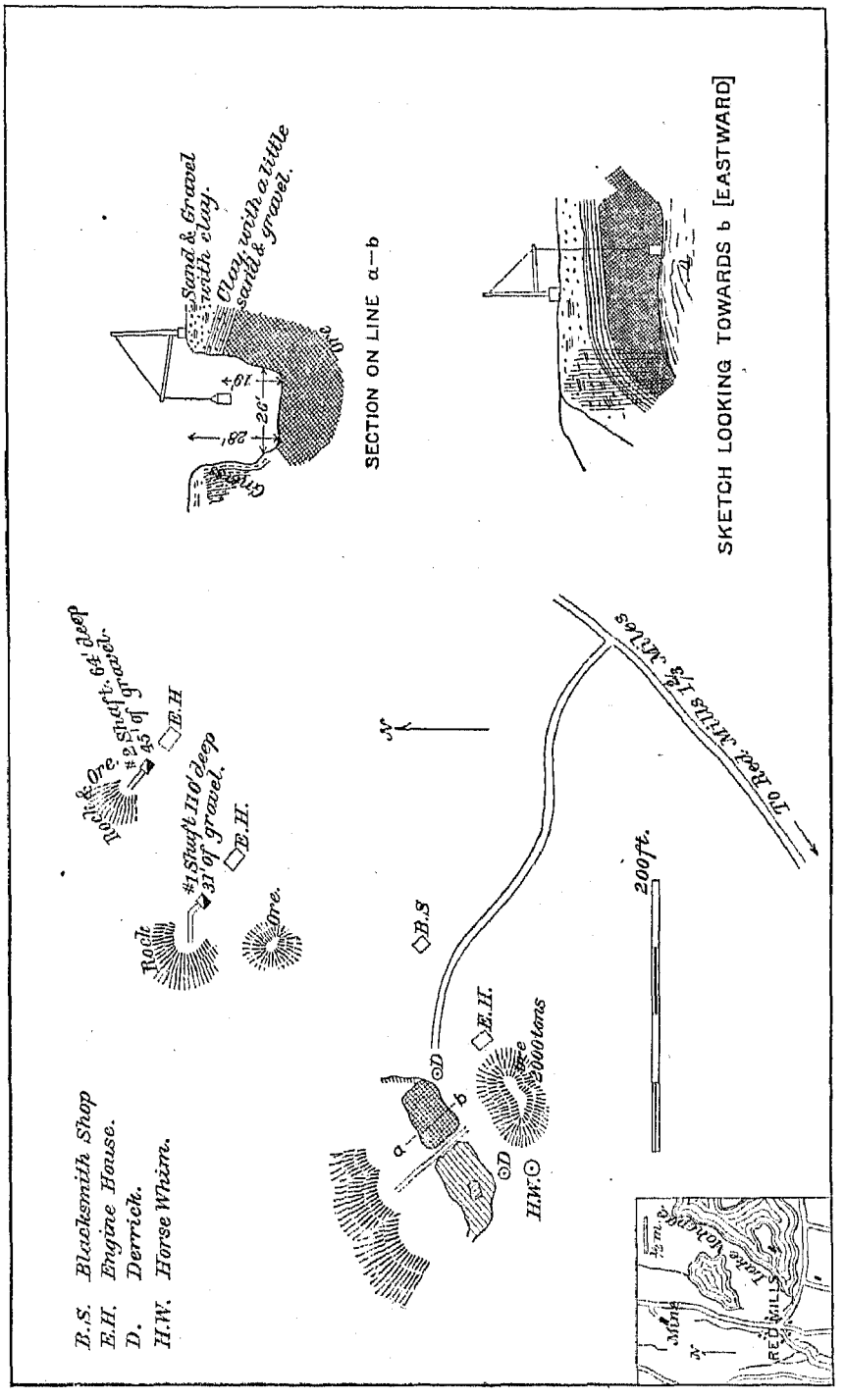


Fig. 18.—Sketch of the Lake Mahopac Iron Company's Mine, Putnam County, New York.

wide. The vein appears to be small and irregular. Its extension southwestward onto the mainland has been opened upon not far from the Dean house. A sample of the ore from the island was taken from a pile of 100 tons at the West Point furnace. It contained—

	No. 729.
	Per cent.
Metallic iron	44.34
Phosphorus	0.021
Manganese	Present.
Phosphorus in 100 parts iron	0.047

a The *Theall* and *McCollum* mines are located in the southwest corner of Southeast township, on opposite sides of the same ridge (see Fig. 19). They are owned and operated by a company known as the "Cheever and Durant Iron mines". The *McCollum* mine was opened in January, 1880. It is worked in open cut, and the ore is run out

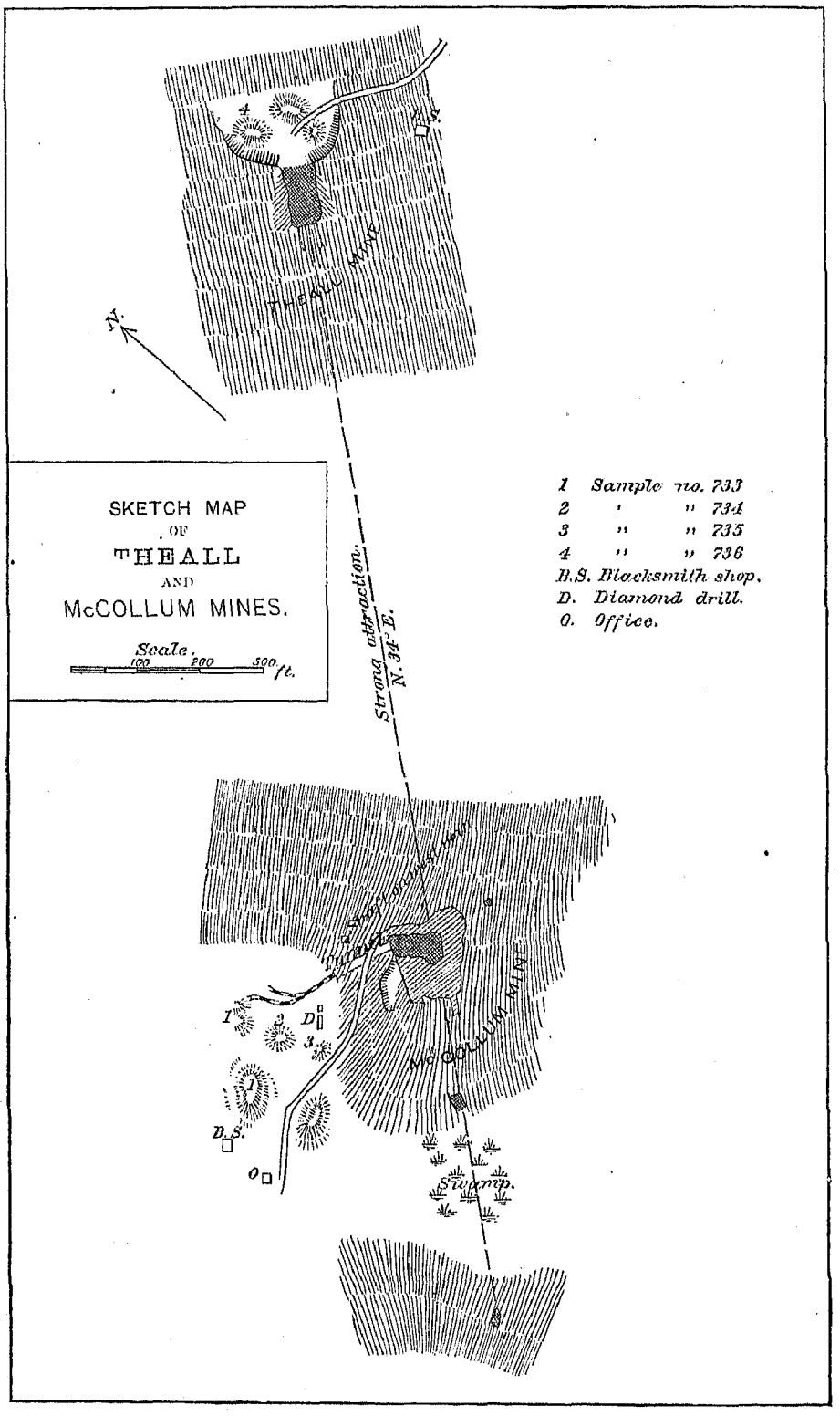


FIG. 19.

through a tunnel on a level with the bottom of the pit. The ore-body is wide, but has no well-defined walls. The ore requires careful hand-picking. Two grades are made. No. 1 is supposed to carry over 50 per cent. metallic iron, and No. 2 over 40 per cent. Masses of pyrite occurring through the ore are picked out as far as possible. About 3,000 tons of ore are (August, 1880) piled at the mine. Of this 100 tons are No. 1, 1,000 tons No. 2, and

the remainder is unsorted; it is, however, chiefly No. 2. With the exception of sample lots sent to different Pennsylvania furnaces no ore has been shipped. Samples taken to represent the two grades of ore contained— a

	No. 733.	No. 734.
	Per cent.	*Per cent.*
Metallic iron	43.22	51.48
Phosphorus	0.255	0.247
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	0.590	0.480

Sample No. 733 is from 1,000 tons No. 2 ore; sample No. 734 is from 100 tons No. 1 ore.

In driving the tunnel a narrow seam of ore was cut before the main mass was reached. A shaft has been sunk b on this seam and about 25 tons of ore have been taken from it. A sample of this contained—

	No. 735.
	Per cent.
Metallic iron	59.86
Phosphorus	0.035
Manganese	Present.
Phosphorus in 100 parts iron	0.058

The great difference in the per cent. of phosphorus in the above and samples Nos. 733 and 734 is noticeable. c

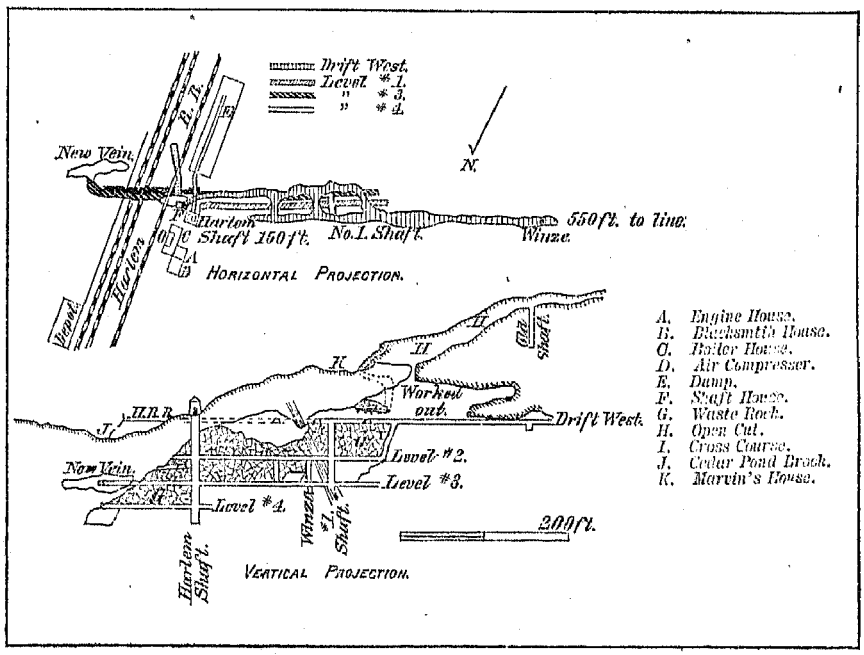
At the *Theall* mine a cut has been driven into the hillside on the vein for about 100 feet, and from the end of the cut a tunnel has penetrated the hill some 50 feet. The tunnel is all in lean ore. Over 5,000 tons of ore have been taken from the cut and tunnel and are now stocked at the mine. A sample from this pile contained—

	No. 736.
	Per cent.
Metallic iron	44.24
Phosphorus	0.260
Phosphorus in 100 parts iron	0.587

d

In its contents of iron and of phosphorus it is seen to agree closely with the "No. 2" ore from the McCollum mine (sample 733); it contains, too, about the same amount of pyrite.

The *Brewster* mine, at Brewster station, was reopened early in February, 1880, by the "Cheever and Durant



f

FIG. 20.

Iron mines", and 1,344 tons of ore were raised in the census year. Previous to this date the mine had been idle for five or six years. All the ore raised in the census year came from a pocket discovered by a drift from the third level, marked "new vein" on the sketch (Fig. 20). Considerable exploring was done after this pocket was exhausted,

a but as no more ore was found the mine was finally abandoned at the end of August. A sample from a pile of 500 tons of ore at the mine contained—

	No. 737.
	Per cent.
Metallic iron	64.09
Phosphorus	0.074
Phosphorus in 100 parts iron	0.115

The *Tilly Foster* mine is situated about 2 miles northwest from Brewster's station, Southeast township, near the
b north end of the recently-constructed storage-reservoir for the Croton aqueduct. It is owned and worked by the

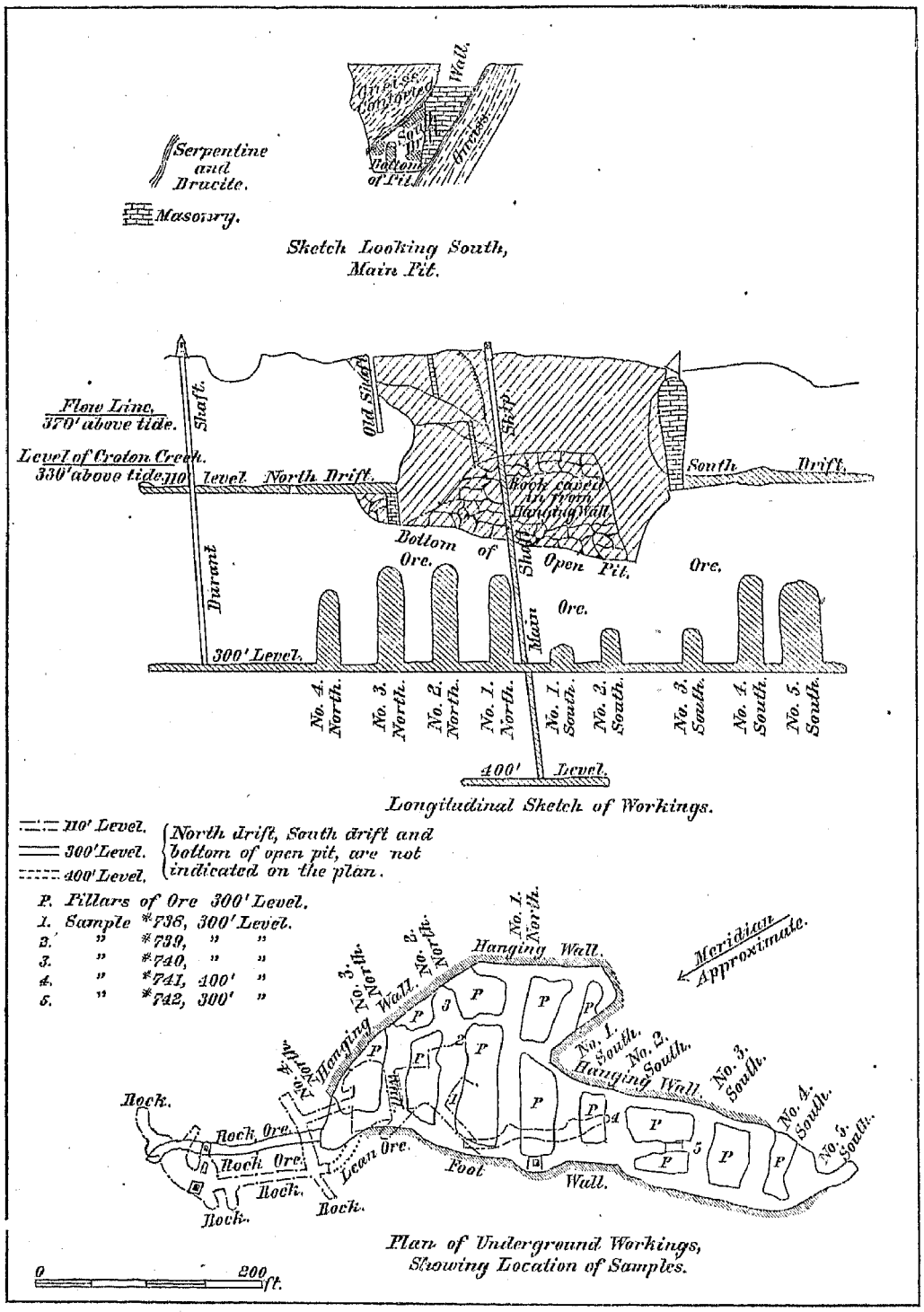


FIG. 21.

Lackawanna Iron and Coal Company. About 56,000 tons of ore were raised in the census year. In the shape of the ore-mass and in the minerals associated with the ore, the mine presents many exceptional features. The ore

has the general direction of the strike of the inclosing gneiss, and the foot-wall is quite regular and dips to the a southeast at an angle of about 70°, but the hanging-wall is extremely irregular, as is shown on the sketch (Fig. 21) of the plan of the 300-foot level. On this level the ore has been worked for a length of over 500 feet, and there is still ore in the end of the drift running south from "Room No. 5 south". The greatest width of the workings is through "Room No. 1 north", where it is about 164 feet. In "Room No. 4 south" the ore is about 70 feet wide, while in "No. 5 south" the hanging-wall has not been reached. From "Room No. 1 north" the walls rapidly approach each other in going northward. On the north side of "No. 4 north" there is only a narrow stringer of ore, and even this is lost in the drift to the Durant shaft, 40 feet from the room. The Durant shaft and all the drifts near it are entirely in gneiss rock.

Above the 300-foot level the wide portion of the ore-mass was exploited in an open cut to a depth of 120 feet. The ore widened as greater depth was reached through the dip of the hanging-wall becoming flatter. Large masses b of rock from the hanging-wall have fallen into the pit so that the width of the original outcrop of the ore cannot be seen. The sketch looking toward the south side of the pit indicates in a measure, however, the relative dip of the two walls. The contortion of the gneiss of the hanging-wall is a peculiar feature. On either side the ore is separated from the gneiss by layers of serpentine (with brucite) or layers of brown mica. Magnetite is distributed through these layers in varying proportions. So far as observed the gneiss contained no magnetite, differing in this respect from the rock usually found near masses of magnetic ore. (*a*)

About 110 feet below the surface, drifts extend both north and south from the open pit. The entrance to the north drift from the pit is closed by *débris* from the wall, but the drift can be entered through the Durant shaft. A chamber of ore is being worked out a short distance north of the pit. The ore is raised through the Durant shaft. c The ore from the south drift is raised through the open pit. A shaft has been sunk 100 feet below the 300-foot level, and a new level is being opened up.

The method employed in exploiting the ore on the 300-foot level (and the same system will be used on the 400-foot and lower levels) is by rooms and pillars. The rooms and pillars extend across the ore-mass, excepting where the latter are cut through by drift-ways. The formation of a room is begun at the level of the drifts, and the ore is blasted from the roof, or, in other words, the roof is "raised". The miners stand on the pile of broken ore and only the surplus ore is removed before the chamber has reached the desired height. When the blasting is finished, the broken ore is taken out of the chamber by laborers while the drilling-machines are at work in another room.

Room No. 2 north had been thus emptied, and a series of samples were taken across the side of the room to determine whether the composition of the ore varied with its position. Sample No. 738 consisted of numerous d chippings taken along the south side of the room from near the foot-wall to a point about one-third of the way across the room. The ore is finely granular and is largely mixed with serpentine and brucite. It has a cubical fracture. Sample No. 739 was taken from the south side of the room near the middle of the ore-mass. The ore resembles No. 738, but contains, perhaps, more serpentine and less brucite. It has a sub-conchoidal fracture. Sample No. 740 was collected from the north side of the room, near the hanging-wall. The ore contains little if any serpentine or brucite. These samples contained—

	No. 738.	No. 739.	No. 740.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	48.01	49.16	46.28
Phosphorus	0.015	0.030	0.017
Phosphorus in 100 parts iron	0.031	0.061	0.037

e

(*a*) In the paper referred to in the foot-note on page 98, Mr. Wendt gives an outline plan of the Tilly Foster mine at the surface and at the 110-foot level, and marks on each plan the position of a diagonal fault which was first suggested by Major T. B. Brooks to account for the shape of the ore-body. The northeast side of the pit, both at the surface and at the 110-foot level, is figured as a sharply flexed line, roughly parallel with the southwest boundary of the deposit, which is similar to that on the 300-foot level as represented in my figure 21. The plan on the 300-foot level does not show this flexure in the northeast boundary, though it is possible that if the "lean ore" marked on the sketch was removed, this boundary would be nearer like that on the higher levels.

The Tilly Foster mine has been so carefully studied by many of the foremost mining geologists of the country, that it is with much hesitancy that I offer any hypothesis of the structure of the ore-mass differing from the one above mentioned, which appears to have been generally adopted. But I cannot forbear noting the similarity between the plan of the 300-foot level of this mine and the section of the f Forest of Dean mine (Fig. 14), for instance, and to suggest the possibility (as a matter for future investigation) that the ore at the Tilly Foster mine may be concentrated along the axis of a compressed and overturned anticlinal, pitching northeasterly, and faulted, perhaps, more or less, on the line of this axis. There are a number of instances of the thickening of a seam of magnetite in the trough of a synclinal, and although I know of no case (unless this be one) of a similar concentration upon the ridge of an anticlinal, I can see no reason why this should not likewise take place under proper conditions. The contorted, and in places, granitoid condition of the gneiss in the southern wall of the open pit is suggestive of a compressed fold rather than of a simple fault.

a Sample No. 738 yielded on complete analysis—

	No. 738.		No. 738.
	Per cent.		*Per cent.*
Sulphur	0.548	Phosphoric acid	0.034
Phosphorus	0.015	Hygroscopic water	0.29
Iron, metallic	48.91	Water of composition	3.79
Silica	12.18	Total	100.175
Iron, protoxide	21.99		
Iron, peroxide	44.75	Per cent. of insoluble silicious matter	13.15
Alumina	0.79		
Manganese, protoxide	0.10	Silica	12.18
Lime	3.10	Alumina (with a trace of oxide of iron)	0.32
Magnesia	11.72	Lime	0.29
Iron, disulphide	1.031	Magnesia	0.27
Carbonic acid	0.40	Total	13.06

b

The following analyses are of samples taken from the different parts of the mine as explained below:

c

	No. 742.	No. 741.	No. 743.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	48.88	51.20	49.66
Phosphorus	0.006	0.016	0.007
Phosphorus in 100 parts iron	0.012	0.031	0.014

Sample No. 742 is from the roof of Room No. 3 south, 300-foot level. Sample No. 741 is from the sides of the drift, 400-foot level. Sample No. 743 was collected from the cars. It represents ore from the 110-foot level raised through the Durant shaft. This differs from the ore from the other part of the mine in that chondrodite forms its
d chief gangue.

Sample No. 743 was subjected to complete analysis, with results as follows:

	No. 743.		No. 743.
	Per cent.		*Per cent.*
Sulphur	0.538	Sulphuric acid	0.05
Phosphorus	0.007	Phosphoric acid	0.015
Iron, metallic	49.66	Carbon in carbonaceous matter	0.01
Silica	10.81	Hygroscopic water	0.16
Iron, protoxide	23.36	Water of composition	0.89
Iron, peroxide	44.30	Total	99.895
Alumina	1.11		
Manganese, protoxide	0.04	Per cent. of insoluble silicious matter	12.07
Lime	1.19		
Magnesia	16.33	Silica	10.81
Iron, disulphide	1.010	Alumina (with trace of oxide of iron)	0.68
Potassa	0.12	Lime	0.30
Soda	0.22	Magnesia	0.45
Carbonic acid	0.28	Total	12.24

e

A sample was collected from the cars to show the average output of the mine, exclusive of the 110-foot level.
f It contained—

	No. 744.
	Per cent.
Metallic iron	48.14
Phosphorus	0.018
Phosphorus in 100 parts iron	0.037

Selected chippings were also taken from the cars of a variety of ore with green mica (sample No. 745), and of a a variety of apparently almost pure magnetite (sample No. 746). These samples contained—

	No. 745.	No. 746.
	Per cent.	*Per cent.*
Metallic iron	30.33	60.01
Phosphorus	0.039	0.014
Phosphorus in 100 parts iron	0.099	0.023

The ratio of phosphorus to iron in sample No. 745 is seen to be comparatively high. But the total amount of b this variety of ore is so small that the general output of the mine could not be seriously affected by it.

B.—WASHINGTON, ESSEX, CLINTON, FRANKLIN, AND SAINT LAWRENCE COUNTIES.

WASHINGTON COUNTY.

The Archæan rocks come to the surface only in the northwestern part of the county, east of Lake George. In this narrow belt magnetic ore occurs at various localities, but it has recently been mined at two points only.

The *Potter* mine is located 4⅜ miles N. 40° W. from Fort Ann (see Fig. 22). It is owned by Joseph Potter, and c was operated in the census year by John T. Harris & Son, who raised 12,172 tons of ore. A part of this was teamed

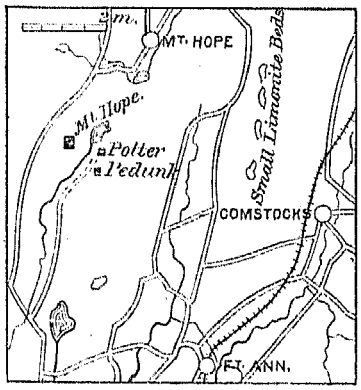


FIG. 22.—MAP OF A PORTION OF WASHINGTON COUNTY, NEW YORK, SHOWING POSITION OF IRON MINES.

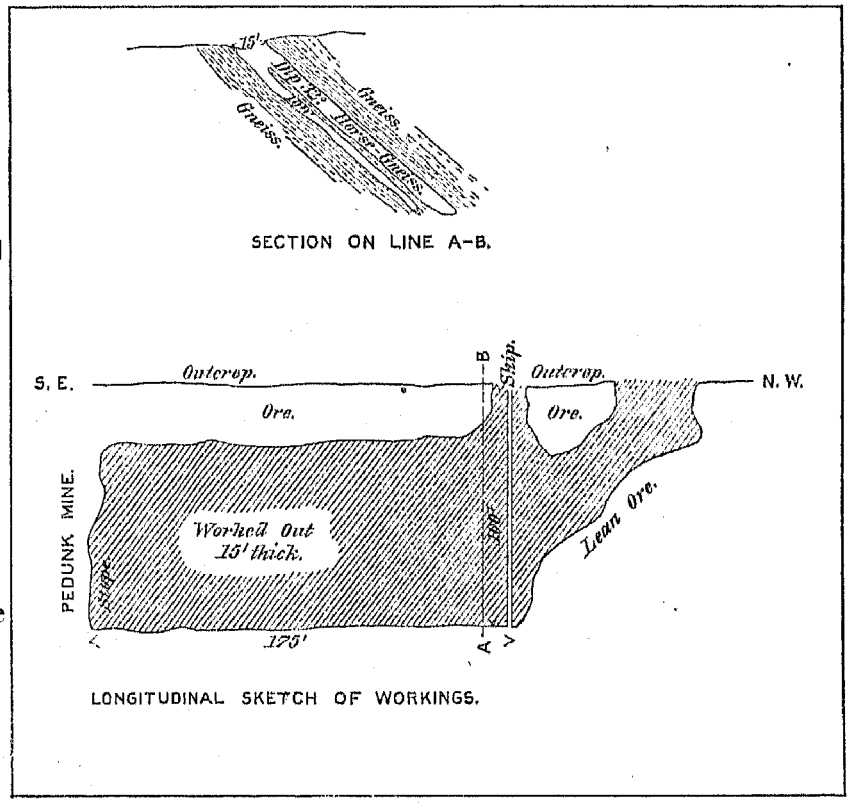


FIG. 23.—SKETCH OF THE POTTER MINE, WASHINGTON COUNTY, NEW YORK.

to the Fort Edward furnace (14 miles), and the balance to the canal at Fort Ann (8 miles), and thence shipped to the different Hudson river furnaces.

The mine is 250 feet northwest of the old Pedunk mine, which was operated many years ago, but has been idle for the past five or six years. The Potter mine was opened in 1879. It has one slope 100 feet in length on the foot-wall, which dips to the northeast at an angle of 32°. A section through this slope is shown on Fig. 23. The seam of rock which separates the ore into two layers increases in thickness toward the northwest, f the layers of ore becoming correspondingly thinner. The line representing the limit of profitable working pitches to the southeast, as is shown on the longitudinal section. Southeast of the slope only the hanging-wall seam has been worked. The stope is 175 feet from the slope, and the ore is there 10 to 15 feet thick. The breast is not far from the underground workings of the old Pedunk mine.

Northwest of the slope the vein can be traced with the dip-needle across the brook. The attraction is slight, however, and explorations in this direction have thus far failed to find a workable body of ore.

The walls of the mine are a hornblendic gneiss of a light-gray color, excepting in immediate contact with the ore, where the color is darker, owing to the presence of more hornblende and of grains of magnetite. The ore is

a granular, occasionally "shotty", and contains more or less pyrite. In places it grades gradually into a magnetite-hornblende gneiss. A sample taken at the mine from a pile of about 1,500 tons of the ore raised since March 1 contained—

	No. 1177.
	Per cent.
Metallic iron	61.82
Phosphorus	Absent.
Titanic acid	Absent.

b About 3,000 tons of ore, mined during the past winter, are stocked near the canal at Fort Ann. The ore appeared to be much leaner than that in the pile sampled.

The *Mount Hope* mine is situated on the mountain of the same name, a half mile northwest of the Potter mine. It is owned by Joseph Potter, and was worked from 1879 to February or March, 1881, by W. P. Ostrander & Co.; 6,720 tons of ore were mined during the census year. The direction of the mountain spur on which the mine is located is nearly north and south, and the ore outcrops on the west, south, and east side of the ridge. It lies quite flat, dipping at from 5° to 10° to the northwest. Four openings have been made on the east side of the hill, and as many more on the west side, and altogether some 15,000 tons of "ore" have been mined and are now stocked near the several openings. Very little ore raised during the past two years has been shipped away. The principal opening consists of a tunnel, 20 to 30 feet wide, driven entirely through the hill nearly on the strike of the ore.

c At the western entrance the ore was about 10 feet thick; at 300 feet from this entrance a pocket of ore 25 feet in thickness was encountered. Beyond this, toward the east, the vein thins down to 3 to 4 feet. The ore has been removed along the south side of the tunnel nearly to the surface-workings from the outcrop. Work to the northward, *i. e.*, toward the dip, has been prevented by water, as there is no pumping-machinery at the mine. The length of the tunnel is between 500 and 600 feet.

Two or three hundred feet north of the western entrance to the tunnel a drift has been driven into the hill, on a seam of ore, 75 to 100 feet, in a southeasterly direction. At the end of this drift there are two seams of ore, 24 and 30 inches thick, separated by 30 inches of rock. North of this drift there are two other openings, now filled with water. I was told they were not extensive.

On the east side of the ridge north of the east tunnel entrance, and evidently on the same "vein" as is the

d tunnel, are two openings, and directly east of the entrance is a third opening which appears to be on another "vein" some 30 or 40 feet below the main one. All these pits were filled with water. The wall-rock is similar to that of the Potter mine.

The ore is finely granular in texture and is largely mixed with hornblende, and to a lesser extent with quartz, feldspar, mica, and, occasionally, pyrite. The greater part of the ore stocked at the mine is very lean, and probably would not average more than 25 to 30 per cent. of metallic iron. It might be hand-picked to run 35 to 40 per cent. A sample from a pile of ore near the western tunnel entrance (which pile appeared to contain better ore than the others) yielded—

e

	No. 1178.
	Per cent.
Metallic iron	36.99
Phosphorus	0.055
Titanic acid	Absent.
Phosphorus in 100 parts iron	0.149

ESSEX AND CLINTON COUNTIES (Fig. 24).

The ores of the Lake Champlain iron region, which is embraced in the above-named counties, at present mined may be grouped under the following heads:

First. Ores high in phosphorus but low in sulphur.

Second. Ores low in both phosphorus and sulphur.

f *Third.* Pyritous ores (usually low in phosphorus?).

Fourth. Titaniferous ores.

Ore of the first class forms the bulk of the shipments from the region. It is mined at the following localities, all in Moriah township, Essex county: *Mine* 21, *Old Bed*, and *Smith* mine (or Cook's shaft), at Mineville, and the *Cheever* mine near Port Henry. In the census year these four mines produced 457,460 tons of ore. The ore averages over 60 per cent. metallic iron.

Mines producing ore of the second class are more numerous and more widely distributed, but the deposits are as a rule smaller, and the ore contains less than 50 per cent. metallic iron. In the census year 259,480 tons of this class of ore were produced (from 14 mines). In the neighborhood of 75,000 tons of this was used in the local forges, after undergoing concentration by burning, crushing, and jigging.

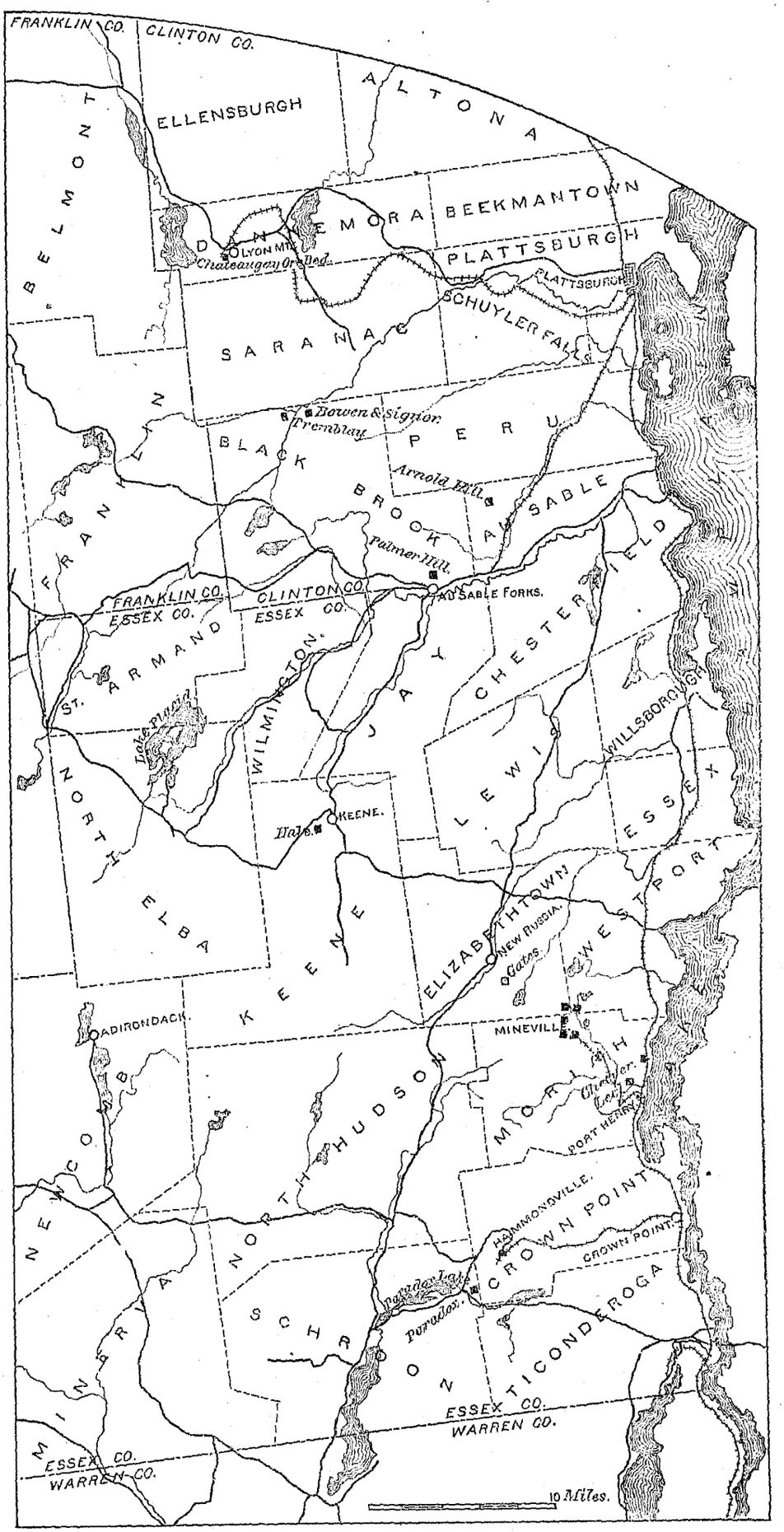


Fig. 24.—Map of the Lake Champlain Iron Region.

a Only one deposit of pyritous ore—the Lee mine, near Port Henry—was worked in the census year.

No titaniferous ore was mined, as it has no commercial value at present. The region could undoubtedly supply a large amount of this class of ore should there ever be a demand for it. Besides the immense masses of it near the old village of Adirondack, described by Dr. Emmons, (*a*) there are other extensive deposits nearer the lake, in Westport township, and elsewhere.

In a paper on the Laurentian iron ore deposits in northern New York, (*b*) Mr. Charles E. Hall states that the titaniferous ores belong to the Upper Laurentian (Labradorite) series, the magnetic ores of Mineville, etc., to the Lower Laurentian, while the relation of the sulphur-ore series he regards as still undetermined.

Phosphatic and non-phosphatic ores are both found in the Lower Laurentian series. At Mineville, however, where they occur near each other, they are seen to occupy different horizons, the phosphatic ore being below the
b ore free from phosphorus.

The most important group of mines in the Lake Champlain region is that near Mineville, Moriah township, Essex county. In speaking of this group, Mr. Hall says: (*c*) "The mines at Mineville, in the township of Moriah, are located about 1,200 feet above the lake level, which is about 100 feet above the level of the sea. These mines are located on two distinct horizons. The beds located on the upper horizon are the *New Bed*, *Barton Hill*, and *Fisher Hill* mines. Those of the lower horizon are 21, the *Old Bed*, and *Cook's Shaft* mines. The general pitch (*d*) of the ore is to the west and northwest where the structure has not been complicated by faults. It is, in many cases, scarcely possible to determine the direction in which the beds pitch, but from all I can learn from careful observation, the deposits at the lower horizon, or those of 21 and the *Old Bed* mines, are on a line of an anticlinal fold, which has been complicated by faults.

c "At the *Cook Shaft* we have clearly a monoclinal, pitching to the westward, as we have in the upper workings of the *New Bed*, *Barton Hill*, and *Fisher Hill* mines."

The accompanying maps and sections, from surveys by William H. Case, C. E., made in part for the owners (*e*) of the mines and in part for the United States Geological Survey, will doubtless prove an interesting contribution to the subject of the structure of these ore-bodies. Plate XXVI shows the entire group of mines, with the exception of some old workings (now abandoned) north of Fisher hill. Plate XXVII shows the Mine 21 and Old Bed mines and Fig. 25 the New Bed and Barton Hill mines on a larger scale.

As stated by Mr. Hall, and as shown in part on Fig. 25, the structure of the western ore-bed, that is of the mines on the upper horizon, is quite simple. At the New Bed and Fisher Hill mines there are two or three overlying beds or lenses of ore, while at the Barton Hill openings there is but one bed. The dip in all the openings is
d toward the west, and usually at an angle below 45°. The inclosing rock is gneiss. The ore from all parts of the upper horizon is alike in containing but little phosphorus. Its principal gangue is quartz. At the New Bed some of the ore consists of a mixture in nearly equal parts by volume of colorless quartz and grains of magnetite. The latter often has a splendent luster, and a specimen of the ore has a very beautiful appearance. The per cent. of iron and phosphorus in the ores from these mines is given below—

	No. 1193.	No. 1358.	No. 1196.	No. 1190.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	43.74	39.15	49.86	46.91
Phosphorus	0.002	0.019	0.048	0.030
Titanic acid	Absent.	Present.	Present.	Present.
Phosphorus in 100 parts iron	0.005	0.049	0.096	0.064

e

Sample No. 1193 is from 5,000 tons of New Bed ore. The sample was collected on the dock at Port Henry. Sample No. 1358 is from three car-loads of ore from the South Barton Hill mine. Sample No. 1196 is from 500 tons of ore from the Barton Hill openings on the hill. The sample was collected at the Bay State Iron Company's furnace. Sample No. 1190 is from 8,500 tons of Fisher Hill ore. The sample was collected on the dock at Port Henry.

The New Bed mine is operated by Witherbee, Sherman & Co. It produced in the census year 31,143 tons of ore.

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f *a Geology Second District*, p. 244, *et seq.* Dr. Emmons does not state that the Adirondack ores are titaniferous. But Prof. James Hall told me that they contained 10 per cent. of titanic acid.

b Reprinted from *Thirty-second Annual Report State Museum Natural History*, Albany, March, 1880.

c Loc. cit., p. 5.

d Mr. Hall has used the word *pitch* to describe what the New Jersey geologists would call the *dip*. The pitch (*i. e.*, the direction of the longer axis of the shoot, lens, or pod) is, in all of the above-mentioned cases, toward the *southwest*, obeying in this what appears to be a general rule for the magnetite deposits of New York and New Jersey, which may be stated thus: When the dip is towards the east the pitch is towards the north; when the dip is towards the west the pitch is towards the south. I know of but two or three exceptions to this rule.

e I am indebted to the Port Henry Iron Ore Company and to Messrs. Witherbee, Sherman & Co. for permission to use Mr. Case's notes of the surveys of these mines.

The Barton Hill mines are worked by the Bay State Iron Company. They produced 11,559 tons of ore in the census year.

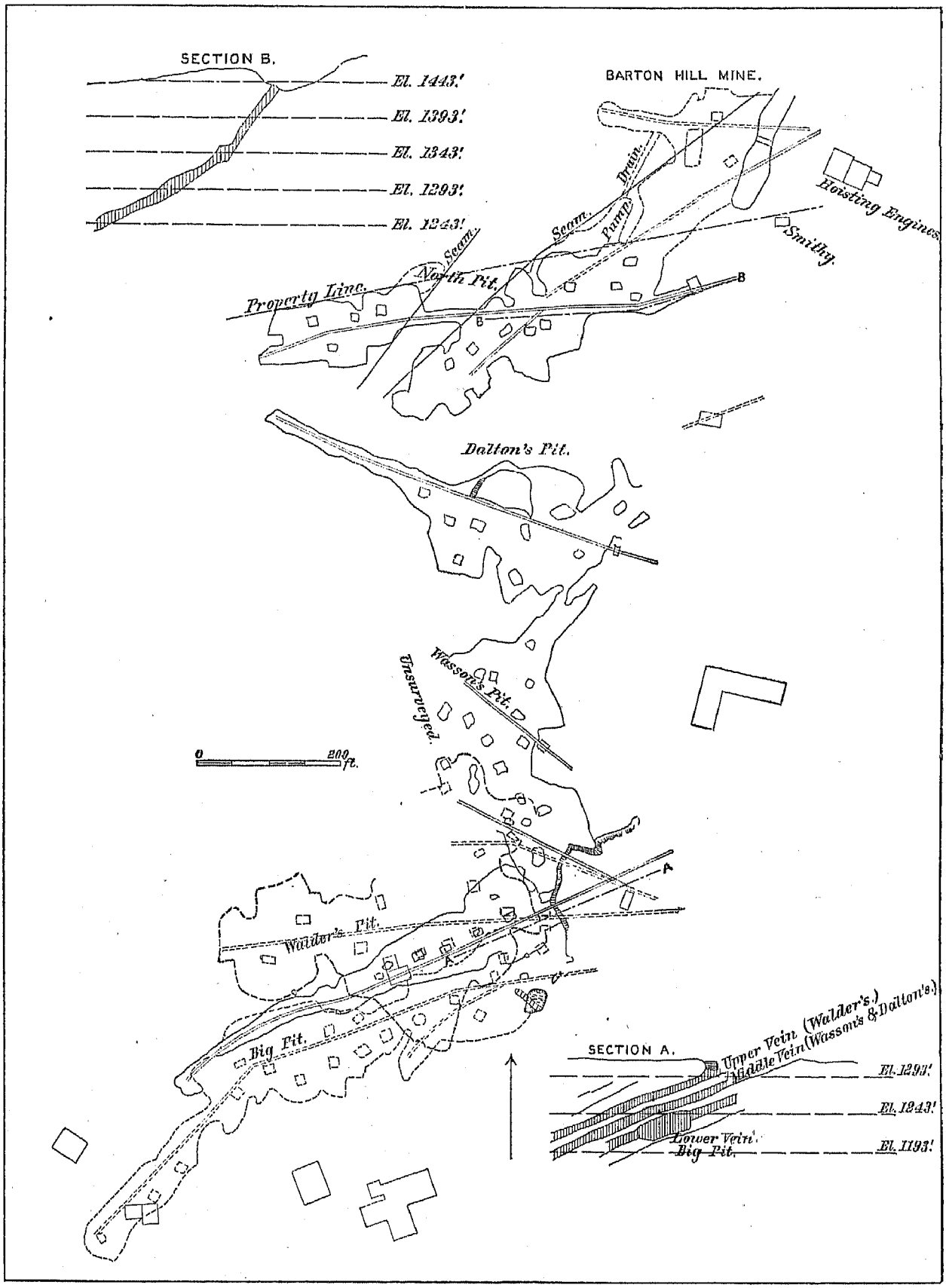

FIG. 25.—PLAN OF NEW BED AND BARTON HILL MINES, NEAR MINEVILLE, ESSEX COUNTY, NEW YORK. From surveys by Wm. H. Case, C. E.

The Fisher Hill mine is worked by the Port Henry Ore and Iron Company. It produced 10,378 tons of ore in the census year.

a Of the beds on the lower horizon, an examination of Plate XXVII will show how complicated is the structure of the group known as *Mine* 21 and *Old Bed* mines.

In the *Brinsmade* mine and *Miller* pit (see sections A and E) the ore dips to the westward, while in Old Bed and Mine 21 (including *Nolan* and *Tefft* shafts) the general dip near the surface is southward.

The *Brinsmade* mine is about 175 feet deep. The ore, which immediately beneath the surface material was about 19 feet thick, has increased, at the bottom of the Welch shaft, to 50 feet in thickness. Toward the north the dip becomes steeper than is shown on section A, and at the north end of the workings it is nearly vertical. From the south end of the mine, and near the roof, a drift has been driven (through rock) westward to the open pit of Old Bed.

In the *Miller* pit the ore has pinched out along the northern, northwestern, and western sides. In the southern
b part of the mine (and here the dip is toward the southwest) there is still a good breast of ore. A peculiar feature in this pit is the S-shaped fold in the walls, which resulted in a breast of ore 115 feet high at one point. This is shown on section E. The dotted line on the plan indicates the limit of the foot-wall fold. Between Miller pit and Old Bed the ground, as is shown in a drift between them and by an excavation westward from near the bottom of the Old Bed workings (which followed a tongue of ore), is much contorted and broken up by seams and faults. The ore-mass in Miller pit is somewhat lower than that in Old Bed. The original connection of these two ore-bodies seems, however, to be well established.

Old Bed was first worked as an open pit, and a large part of the hanging-wall has been taken down, so that the width of the ore at the outcrop cannot now be seen. The eastern half of the pit was worked by the Port Henry Ore and Iron Company and the western half by Witherbee, Sherman & Co.; the property-line is a meridian
c passing near Potts' shaft. The roof in the underground workings of the Port Henry Ore and Iron Company has fallen in. The workings were never surveyed, but the southern side of the pit is shown approximately by the dotted line. Along it there is said to be a breast of ore 7 to 10 feet high. The workings on Witherbee, Sherman & Co.'s property extend 175 to 300 feet beyond the southern edge of the open pit. Referring to the plan, the solid line about midway between the edge of the open pit and the southern end of the workings indicates where the foot-wall makes a sharp bend downward and forms an "S"-shaped fold, the ore following in under the rock, as in Miller pit (section E). The relation of the Potts' shaft ore-mass to the rest of Old Bed has, I believe, always been considered difficult to explain; but by carefully comparing sections D and F(*a*) I think an "S"-shaped fold, increasing toward the east, is at once suggested. Since the axes of the two portions of the fold are not parallel, the ore below the fold would necessarily have a different direction of strike and dip from the ore above the fold;
d and this we find to be the case in Potts' shaft, where the dip is toward the southeast (at an angle of about 80°). The bottom of the pit south of the edge of the foot-wall fold is covered with ore. Work was suspended in this part of the mine on account of the frequent fall of masses of rock from the roof above. At the west, however, a shaft was sunk in the floor through 30 feet of ore and a lower chamber then opened. The shape of this chamber is indicated by a dotted line. The sides are ore. A partial section through the chamber is shown at F. This part of the ore-bed corresponds, I think, in its relation to the S-shaped fold, to Potts' shaft. In working southward from Potts' shaft, the dip will, under this hypothesis, gradually flatten, and the direction of the strike will change to southwesterly. When the ore is all removed the workings will be continuous with this lower chamber. The floor at the eastern end of the old pit corresponds in like manner to the bottom of the upper fold in the hanging-wall ("*a*" in section F). The southern wall of the pit is produced by the upper fold, as is indicated
e in the sections. On the east the pit is bounded by a vertical wall 30 or 40 feet high. The Port Henry Ore and Iron Company's workings extend eastward from the top of this wall, which probably is the face of a fault.

Excepting in Potts' shaft, the only work being done in Old Bed, when visited in July, 1881, was in the extreme southwestern portion of the mine, at the end of the western slides, where there is a breast of ore 10 or 12 feet high. The fold appears to die out in a pillar of ore somewhere between this stope and the lower shaft.

Mine 21 is about 300 feet south of Old Bed. The workings consist of an open pit 250 feet deep, and at the bottom, about 250 feet across in an east and west direction and 150 feet in a north and south direction. The bottom of the pit is all ore. The north side is lean ore, but on the other three sides the workings have been carried in underneath a roof of gneiss. As in Old Bed this roof originally extended part of the way across what is now the open pit. At section B the vertical distance from the bottom of the pit to the rock roof is 130 feet, which is the
f height of one of the pillars. Near the north side of the pit a vertical drill-hole struck rock 60 feet below the pit's bottom. Should this prove to be the foot-wall, the normal thickness of the ore at this point would have been about 230 feet (see section B). East of the open pit the ore has been exploited in two levels. The boundary of the lower level is indicated on the plan by a dotted line. No foot-wall has been uncovered anywhere in the mine.

It appears to me quite probable that the great thickness of the ore in this mine is due to a fold in the walls similar to that in the Miller pit. I have indicated the supposed fold in the hanging-wall or roof on sections B, C, and D by a dotted line. The true position of this line is undeterminable at present (1881). A suggestion of such a fold was observed in the southwestern side of Tefft shaft pit, where the roof appears to be beginning to bend downward.

---

a Section F is a sketch merely. The main facts are correctly indicated, but in the details may be a slight error.

About 750 feet south of Mine 21 explorations with the diamond-drill discovered ore. One shaft has been sunk a to this ore and a second one has been started. The location of the shafts is shown on Plate XXVI. The eastern shaft reached the ore at a depth of 156 feet at an incline of 78°. The ore dips southward at about 10°, and has been explored by a drift 180 feet long driven southward from the bottom of the shaft. At the end of this drift the ore is about 9 feet thick, but it appears to be lean. The drift is very wet, and the ore is all more or less peroxidized. A sample of the ore from a pile of 75 tons at the top of the shaft contained—

	No. 1350.
	Per cent.
Metallic iron	52.58
Phosphorus	0.019
Phosphorus in 100 parts iron	0.036

b

With the exception of the above, and a narrow seam of compact ore in the surface-workings of Mine 21, the ores from the different pits of this group of mines are almost identical in appearance. They are coarse-grained, "shotty" ores, generally fragile (*more than one-half of the shipping product is fine ore*), and always largely mixed with granules of brownish-colored apatite. Mine 21 is said to have been first worked as an apatite mine. Samples of ore collected from the different pits contained—

	No. 1351.	No. 1353.	No. 1354.	No. 1355.	No. 1356.	No. 1357.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	57.71	61.39	60.54	61.53	62.64	61.92
Phosphorus	1.266	1.282	0.830	1.302	0.908	0.876
Titanic acid	Present.	Present.	Present.	Present.	Present.	Present.
Phosphorus in 100 parts iron	2.194	2.088	1.371	2.116	1.449	1.253

c

Sample No. 1351 is from the Brinsmade mine, *south end (broken ore in stope)*; *sample No. 1353 is from Nolan* shaft (on cars at top of shaft); sample No. 1354 is from Miller pit (pile of ore at top of slope); sample No. 1355 is from Potts' shaft (pile of ore at top of slides); sample No. 1356 is from Old Bed, southwest side of pit (on cars and d pile of ore at top of slides); sample No. 1357 is from Tefft shaft (on cars at top of shaft).

East of section B, Mine 21, on the north side of the pit and near the surface, the stripping has been removed from a mass of partly-weathered ore which is now being mined. A sample was taken from a pile of 16,000 tons of this ore, on the dock at Port Henry. The sample contained—

	No 1180.
	Per cent.
Metallic iron	62.10
Phosphorus	1.108
Titanic acid	Present.
Phosphorus in 100 parts iron	1.928

e

The above ore is known as surface-ore. It is chiefly coarsely granular, but there are seams near the north wall of a compact ore which has a peculiar metallic luster. A separate sample was taken to represent this variety. The sample contained—

	No. 1352.
	Per cent.
Metallic iron	67.38
Phosphorus	0.465
Titanic acid	Present.
Phosphorus in 100 parts iron	0.689

f

Samples representing the shipping product of the pits worked by the Port Henry Ore and Iron Company, collectively known as "Mine 21", *i. e.*, Mine 21 proper, Nolan shaft, and Brinsmade mine, were taken from the large stock-piles at Port Henry.

(*Note.*—The "surface ore" is shipped separately and is not included in these samples.)

a The samples contained—

	No. 1187.	No. 1188.
	Per cent.	*Per cent.*
Metallic iron	61.39	62.66
Phosphorus	1.496	1.118
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	2.437	1.784

Sample No. 1187 is from 30,000 tons of lump-ore; sample No. 1188 is from 40,000 tons of fine ore.

b The shipments from "Mine 21" in the census year amounted to 187,448 tons.

The character of the ore shipped from the pits worked by Witherbee, Sherman & Co., which are collectively known as "Old Bed", *i. e.*, Old Bed, Potts' shaft, Miller pit, and Tefft shaft, is shown in the following analyses:

	No. 1191.	No. 1192.
	Per cent.	*Per cent.*
Metallic iron	61.46	63.01
Phosphorus	1.129	0.967
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	1.837	1.535

c

The samples were collected from the stock-piles at Port Henry. Sample No. 1191 is from 23,000 tons of lump-ore; sample No. 1192 is from 38,000 tons of fine ore.

In the census year 208,416 tons of ore were shipped from "Old Bed", and this, with the shipments from "Mine 21", makes a total of 395,864 tons of ore—all mined within an area 1,400 feet long by 1,000 feet wide. Such an amount of ore is not reported to have been produced elsewhere from so small an area of territory in one year. The total production of these mines is estimated at 3,[illegible]84,000 tons.

Smith mine (formerly known as Cook's shaft) is located nearly a mile and a quarter due north from Old Bed. The ore lies in a single shoot which pitches toward the southwest at an average angle of about 30°. At the breast d the shoot is almost 140 feet wide. The ore is about 25 feet thick at the middle, but it thins down on either side. The approximate outline of the workings is shown on Plate XXVI. The mine is owned by H. T. Burler & Brother, and is worked by George B. Stimpson. In the census year it produced 16,800 tons of ore. The ore is like that in Old Bed and Mine 21. Samples collected on the dock at Port Henry contained—

	No. 1194.	No. 1195.
	Per cent.	*Per cent.*
Metallic iron	62.66	62.80
Phosphorus	0.946	0.870
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	1.510	1.385

e

Sample No. 1194 is from 200 tons of lump-ore; sample No. 1195 is from 3,000 tons of fine ore.

The *Cheever* ore-bed is situated about 2 miles north of the village of Port Henry, and about one-quarter of a mile from the shore of Lake Champlain. The outcrop of the ore was a little over 200 feet above the lake level. The mine is owned and operated by the Cheever Ore Bed Company. In the census year it produced 44,800 tons of ore.

The sketches on Fig. 26 will give a general idea of the shape of the ore-body. The longitudinal section and the cross-sections A B and E F were measured with a tape, and the levels were run with a lock-level and a light rod. The rod was read to 0.05 foot. While no great degree of accuracy was possible with this instrument, the errors are, it is believed, not appreciable on the scale of the sketch. The original plat was made on a scale of 100 feet to f the inch, and from this the sketch was reduced by pantograph. The plan of the mine was made from a few measurements only; it simply indicates the general outline of the pit. The workings, as I was informed by Mr. Presbrey, the superintendent of the mine, cover about 30 acres.

The original outcrop of the ore extended in nearly a straight line along a little depression in the hill S. 4° 45′ W. for 690 feet; then bending a few degrees to the east, it continued 150 feet in this new direction. The total length of outcrop was therefore nearly 850 feet. For a distance of 125 feet north of the bend there is only one bed of ore. At this point a second bed makes its appearance above the first. A section 140 feet from the bend is shown at G H, where the upper bed is 5 feet thick, the lower one 16 feet thick, and the two are separated by 19 feet of gneiss rock. Continuing northward the two beds approach each other, and the lower one becomes thinner. The dip at the surface also flattens, as is seen in section I J. A short distance north of this section the lower bed

thins out altogether. Between the sections G H and I J the lower bed is continuous, but the workings on the upper bed form, at the outcrop, two distinct pits separated by barren ground. Whether these pits are connected deeper down I did not ascertain. A section of the upper bed at I J was roughly measured as far down as the water.

Returning to the southern end of the outcrop, the following measurements are noted on the line of the main section, as the scale is too small to make them apparent on the sketch: At the outcrop the dip is 55°; the thickness of the ore was 13.8 feet. In descending, the dip gradually flattens, until at a vertical depth below the outcrop of 287 feet it is 35°. The distance between the walls down to this point varies from 10.2 to 14.2 feet. At the point marked "station 1" on the section, (*i. e.*, at the foot of the stairway) the bed flattens rapidly. The ore was here 19 feet thick.

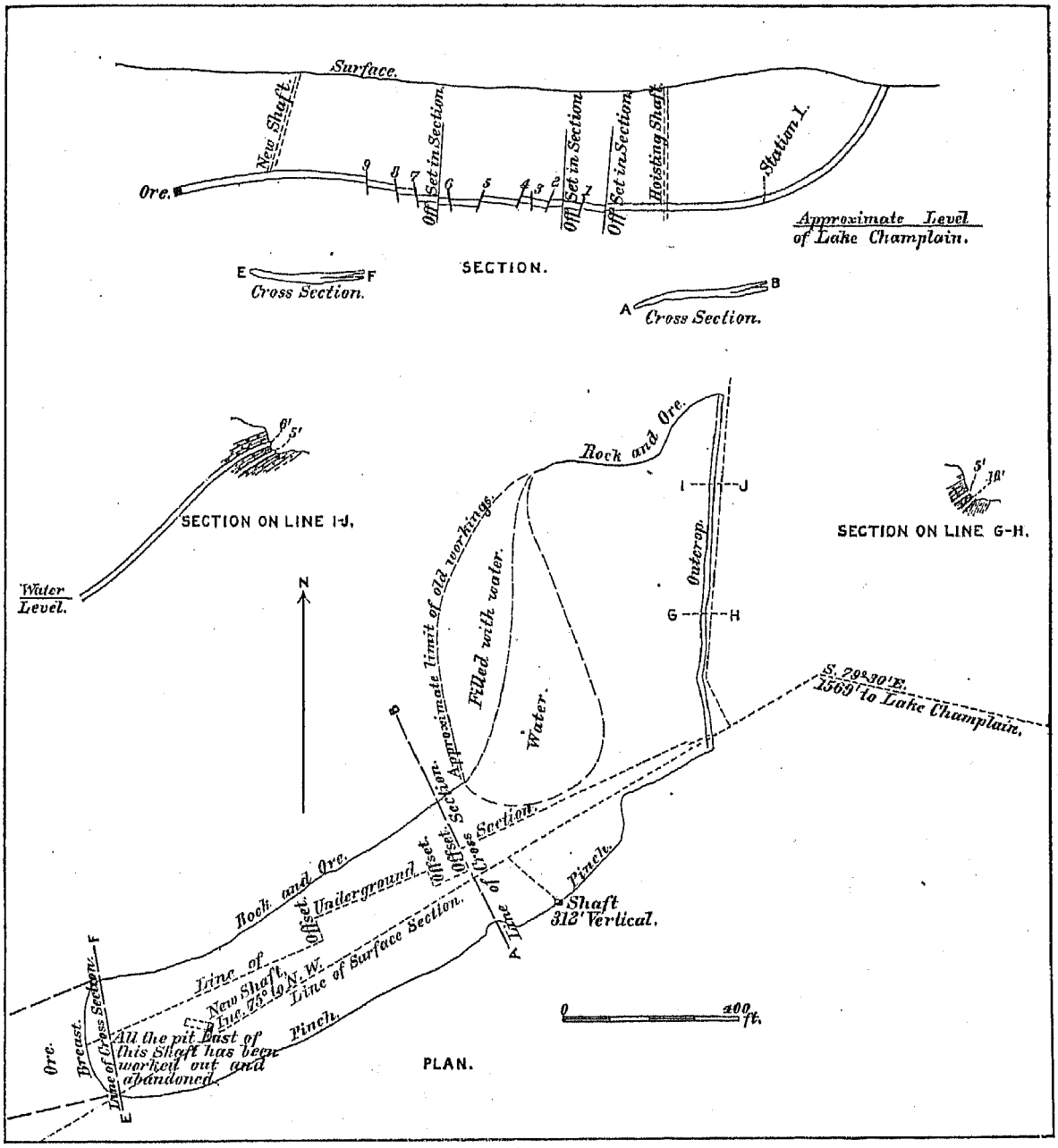

FIG. 26.—SKETCH OF THE CHEEVER ORE-BED, ESSEX COUNTY, NEW YORK.

NOTE.—The scale of the section is the same as that of the plan, and in the section the horizontal and vertical scales are equal.

Becoming nearly horizontal the walls approach to within 6.8 feet of each other 200 feet from station 1. Station S, 345 feet from station 1, is over 300 feet vertically below the level of the outcrop and is the lowest point on the line of the section. It is not, however, as low as the bottom of the old shaft, as can be seen from the cross section A B. At 395 feet from station 1 an offset was made in the line to avoid a pillar, and at 445 feet from the same point the first fault is met with. The displacement at the section-line is 1.5 feet *downward*. The displacement increases toward the north and decreases toward the south. In the latter direction the line of fault bends around so as to have a nearly east and west course, crossing the cross-section A B, where the displacement is but a few inches. Another offset in the section-line was necessary 493 feet from station 1. Five hundred and eleven feet

a from station 1 a second fault occurs, with a downward displacement of 1.6 feet, and 42 feet beyond this a third, with an upward movement of 2.1 feet; 28 feet beyond the third fault is a fourth one, with a downward displacement of 4.5 feet. The fifth fault is 57 feet from the fourth and 691 feet from station 1. Here, also, the displacement is downward—31.1 feet. At the sixth fault, 762 feet from station 1, there is an upward displacement of 9 feet, and at the seventh a similar one of 13.5 feet. This latter is the greatest displacement anywhere observed. The fault extends across the pit in a general northwest and southeast direction, and entirely "cut out" the ore, the continuation of which was only found after much exploring; this fault is 840 feet from station 1. West of it are two others, Nos. 8 and 9, 888 feet and 961 feet from station 1, respectively. The displacement at No. 8 is 8.5 feet, and at No. 9, 8 feet. [The amount of displacement given is always on the line of the section. It sometimes b increases toward the north, sometimes toward the south, and occasionally dies out altogether; or the fault runs into another one forming a wedge-shaped piece of ground, which has been displaced to a more or less extent than the surrounding rock. Such a piece is seen between faults Nos. 2 and 3 and Nos. 5 and 6. A more marked instance is near fault No. 7, but south of the line of the section, where a triangular mass of ground has *sunk*. The amount of displacement here is not known, but it is greater than the thickness of the ore.]

Along the line of the section in the faulted region the ore varied in thickness from 7½ to 12½ feet.

The inclination of the face of the faults, or their *hade*, is indicated on the sketch, and it is seen to give in all cases the clue to the direction of the displacement. The faults are all normal. Although the faults are both upward and downward, the greater displacement, as well as the general inclination of the strata between the faults, is upward toward the west. Station 24, above fault No. 9, is 31 feet above station 1, and 48 feet above station 8, c the lowest point on the line. From fault No. 9 the ore-bed rises gradually for about 200 feet, to the bottom of the new shaft, where it is some 40 feet above station 1. From this point the ore pitches downward, so that the breast, 225 feet from the shaft, is 42 feet lower than the latter. The thickness of the ore along the section line between fault No. 9 and the breast varied from 8.8 to 11.7 feet.

From the old shaft to the breast the width of the ore-body varied but slightly. On the line of the section E F the width of the pit is 271 feet. The bed is here trough-shaped. From the outcrop to the breast the pit is bounded on the south by a pinch. Explorations south of this pinch have thus far failed to find ore. Near the middle of the breast, and about midway between the "roof" and the "floor", the bed of ore is divided by a thin seam of feldspathic rock, which gradually increases in thickness toward the north, and finally almost entirely replaces the ore. Mining is stopped in a northward direction as soon as the limit of profitable working is reached. There are d two seams of ore, one near the floor and one near the roof, all along the north wall of the pit. I understand that explorations have never been carried northward to the point where the ore entirely disappeared.

Along the outcrop, the rock near the ore is a hornblendic gneiss, often with part of the hornblende replaced with magnetite. The new shaft passed through garnetiferous gneiss, white crystalline limestone, hornblendic gneiss, and micaceous gneiss. About a quarter of a mile north of the mine is a quarry of white limestone with serpentine. A layer of serpentine schist was observed on the face of fault No. 7, in the mine.

The ore is all coarsely granular, and contains brownish grains of apatite. It is similar in every respect to the ore from Old Bed and Mine 21. To determine if the per cent. of phosphorus varied in the different parts of the bed, four samples were taken from the breast. Sample No. 1181 is from near the south wall; the chippings were taken from the roof to the floor. Sample No. 1182 is from the middle of the breast—from the floor to the seam of e rock, Sample No. 1183 is also from the middle of the breast, but it is from the upper part of the bed—from the seam of rock to the roof. Sample No. 1184 is from near the north wall—from roof to floor (exclusive of the rock seam). Before the samples were ground they were emptied onto a sheet of paper and the numerous chippings were carefully examined. Not a single chip was found without apatite. The samples contained—

	No. 1181.	No. 1182.	No. 1183.	No. 1184.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	65.33	63.50	63.86	64.42
Phosphorus	0.643	0.603	0.689	0.452
Titanic acid	Present.	Absent.	Present.	Present.
Phosphorus in 100 parts iron	0.984	0.950	1.079	0.702

f About two-thirds of the ore comes from the mine as fine material. The large lumps are picked out and shipped separately, as they are usually considered more desirable for use in the furnace. Samples were taken from large piles of lump and fine ore on the dock, to represent the shipping product of the mine. These samples contained—

	No. 1185.	No. 1186.
	Per cent.	*Per cent.*
Metallic iron	64.77	63.08
Phosphorus	0.673	0.573
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	1.039	0.908

The lump-ore is represented by sample No. 1185, and the fine ore by sample No. 1186.

The *Lee* mine is located on the hill north of the northern boundary of the village of Port Henry, and on the east side of the road between Port Henry and Mineville. The mine is owned by J. A. Lee, esq, and was last operated by Milo J. Jennings, recently deceased. In the census year 6,160 tons of ore were raised. In the neighborhood of 4,000 tons were stocked at the mine when visited; the mine was idle. The extent of the developments is shown in Fig. 27, on which the dotted lines on the plan indicate approximately the limits of the

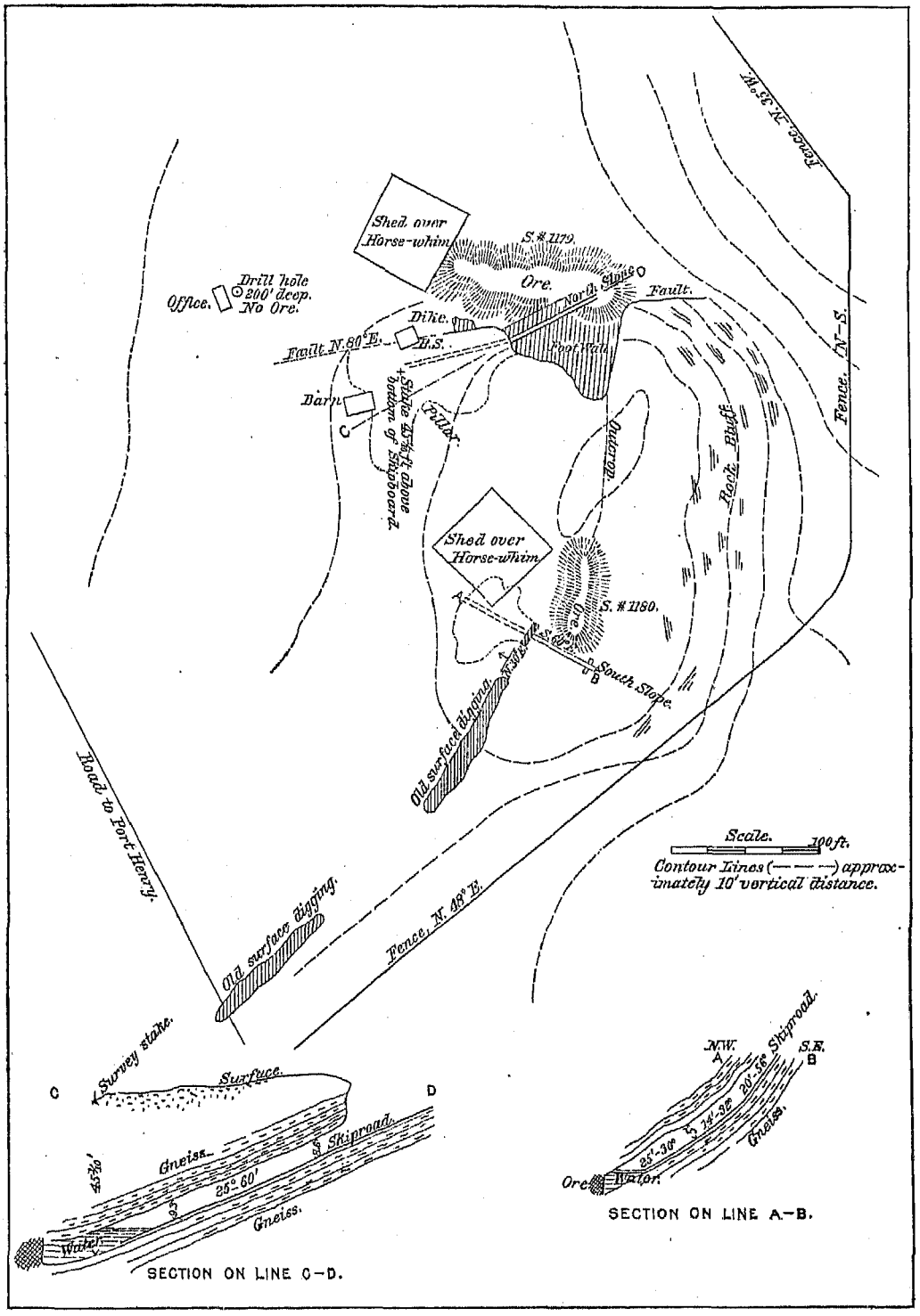

FIG. 27.—SKETCH OF THE LEE MINE, ESSEX COUNTY, NEW YORK.

underground workings. The ore is cut off on the north by a basaltic? dike, along the south side of which there has apparently been an upward movement of the country. The north side of the hill or knoll presents a vertical wall, which terminates at the east in a rocky bluff (a series of north-and-south faults?). Search has been made for the continuation of the ore by a diamond-drill hole near the office. I was told that this hole had penetrated to a depth of 200 feet without striking ore, and had then been abandoned. All the cores that I could find about the top of the hole were dike-rock. I could not learn whether other rock had been passed through. If not, the

a hole, of course, proved nothing excepting as to the *width* of the dike. The hole should have been located farther north. On the crest of the hill, near the north opening, the outcrop of the ore can be traced in a nearly southerly direction for about 100 feet. At the south slope the strike is south 30° west, indicating a change in direction of 30° in a distance of 25 feet. The point of actual bend is covered with a pile of ore. The old surface-workings near the road have a direction of south 40° west, and indicate, therefore, a further bend in the outcrop.

The ore is in the main finely granular and contains considerable pyrite. It would probably require roasting before it could be used in the blast-furnace. The per cent. of phosphorus and iron is shown below:

b

	No. 1179.	No. 1180.
	Per cent.	*Per cent.*
Metallic iron	45.01	44.38
Phosphorus	0.047	0.04
Titanic acid	Absent.	Absent.
Phosphorus in 100 parts iron	0.104	0.077

Sample No. 1179 is from 2,500 tons of ore from the north opening; sample No. 1180 is from 1,500 tons of ore from the south opening.

The *Crown Point* mines are situated at Hammondville, Crown Point township, Essex county, 13 miles west of the village of Crown Point. They are operated by the Crown Point Iron Company. In the census year 112,000 tons of ore were mined. A narrow-gauge railroad connects the mines with Lake Champlain. As is shown on Fig. c 28, reduced from a map of the mines, the latter consist of 30 or 40 small openings, distributed over an area one mile and a quarter long by three-quarters of a mile wide. The topography of the district is mountainous, and the geology is complicated by numerous folds and faults. It would require very careful study to solve the many structural problems here presented. But from the facts observed I think it probable that the numerous beds belong practically to the same horizon, the repetition of outcrop being caused by several folds and faults. The dip in the eastern and western lines of openings is toward the east, but in the Penfield pit, between them, we clearly have an anticlinal fold, the western slope of which has been cut by a dike and faulted.

The ore from all the pits is very similar in appearance, and is, with the exception of the product of one or two pits, sufficiently free from phosphorus to be used for Bessemer steel. In pit No. 8, on Hammond hill, the ore recently mined contains apatite, although when the pit was first opened the ore was non-phosphatic. This pit was idle d when the locality was visited, but a sample was collected from a pile of 7,000 tons of the ore raised during the past winter. This sample contained—

	No. 1348.
	Per cent.
Metallic iron	50.73
Phosphorus	0.090
Titanic acid	Present.
Phosphorus in 100 parts iron	0.177

e A sample of the general shipping product of these mines, exclusive of pit No. 8, was taken from a pile of 3,000 tons of ore on the dock at Crown Point. The sample contained—

	No. 1340.
	Per cent.
Metallic iron	49.09
Phosphorus	0.029
Titanic acid	Present.
Phosphorus in 100 parts iron	0.059

The ore is a mixture of magnetite, quartz, hornblende, and feldspar. A portion of it contains too little f magnetite for furnace use, and this is sent to Irondale (about 6 miles from the mines, toward Crown Point), where it is used in the company's forges, after being "separated" in the usual manner. A sample of the separated ore contained—

	No. 1347.
	Per cent.
Metallic iron	63.30
Phosphorus	0.030
Titanic acid	Present.
Phosphorus in 100 parts iron	0.047

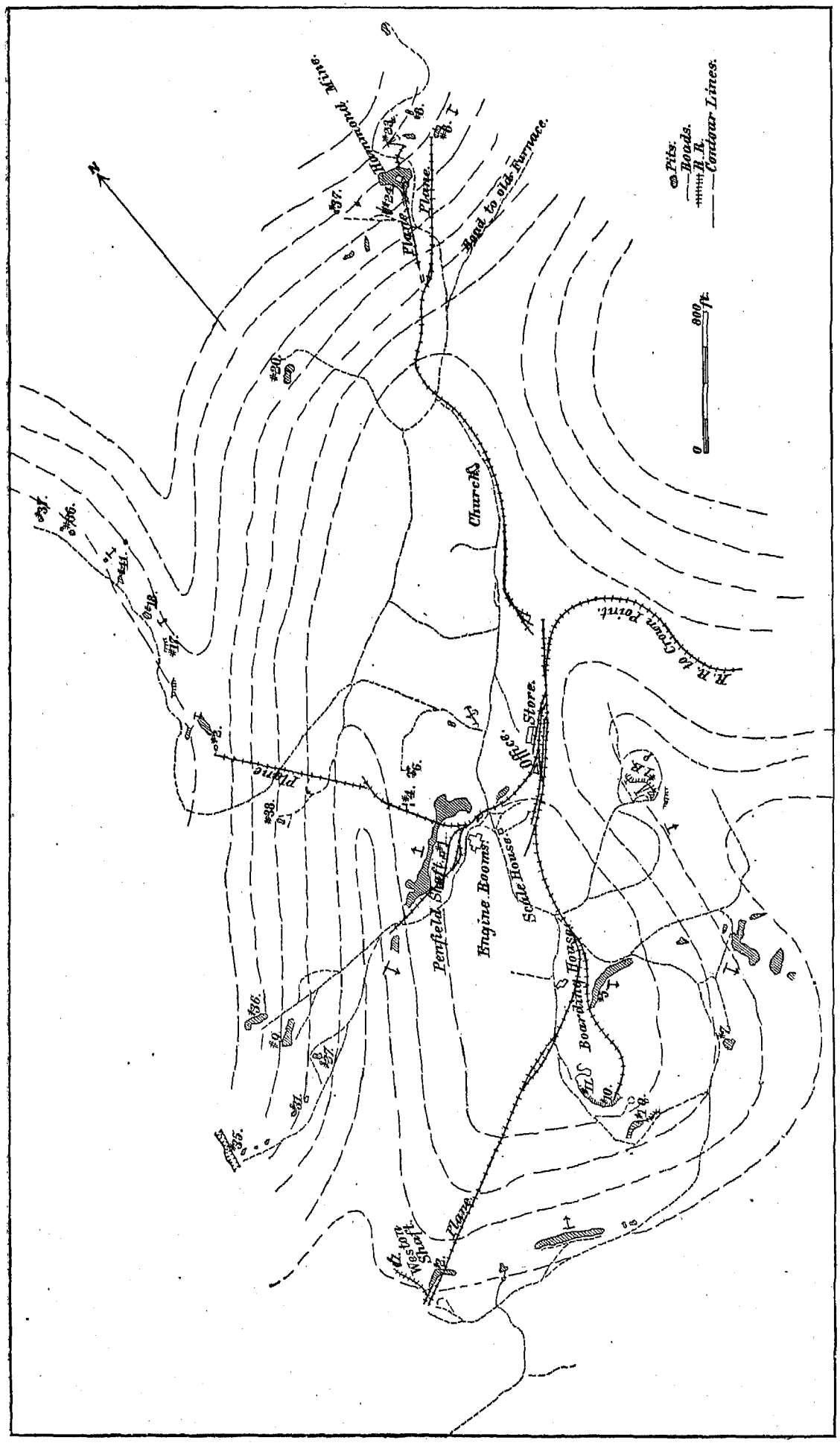

FIG. 28.—MAP OF THE CROWN POINT IRON COMPANY'S MINES AT HAMMONDVILLE, ESSEX COUNTY, NEW YORK. From surveys by William H. Case, C. E. The contour lines indicate approximately the surface features.

a Southwest of Hammondville, in Schroon township, near Paradox lake, two small mines were worked in the census year, and together produced 560 tons of ore. The ore was used in forges at Ticonderoga and at Schroon river. The mines were not visited and the ore was not sampled.

The *Gate's* or *Putnam* mine is situated in Elizabethtown township, northwest of Lincoln pond, and about 1 mile southeast of the village of New Russia. It is on Gate's farm, but the mine itself has recently been bought by Herbert A. Putnam, and is worked by him for the supply of his forge at New Russia. The existence of a vein of ore here has long been known, and about twelve years ago the Bay State Iron Company opened a mine some 50 rods north of the present workings. Their pit is reported to be between 200 and 300 feet deep (measured on the dip). It is now full of water. Work on the Putnam mine was begun in January, 1880. In May, 1881, the pit was about
b 100 feet deep, measured on the foot-wall, which dips 57° to the west, and at the bottom 60 feet long. The ore varies in thickness from 18 inches along the sides of the pit to 4 feet in the middle. It will average, perhaps, 30 inches. The direction of the outcrop is a few degrees west of north.

A part of the ore is coarsely granular and contains granules of apatite. Before it is used in the forge it is concentrated in the usual manner. Sample No. 1197 represents the ore as it comes from the mine, and sample No. 1198 the separated ore. The samples contained—

c

	No. 1197.	No. 1198.
	Per cent.	*Per cent.*
Metallic iron	43.21	64.14
Phosphorus	0.456	0.136
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	1.055	0.212

It takes about 2 tons of "primitive" ore to make 1 ton of separated ore.

The *Hale* mine is located on Long Pond mountain, about 1 mile southwest of the village of Keene, Keene township. It is worked by W. F. and S. H. Weston. The ore lies in white crystalline limestone. The first opening made in the vicinity is on the Wood farm, which adjoins the Hale farm on the west. The Wood mine was opened by the Westons in 1872, and was abandoned in December, 1880. It produced 1,120 tons of ore in the census year. The ore formed a shoot 8 to 16 feet wide, which dipped at a high angle to the northwest and pitched to the northeast at an average angle of 45°. The pit is said to be between 250 and 300 feet deep (measured on the bottom-
d rock of the shoot). Crystalline limestone surrounded the ore on all sides and was intimately mixed with it. From specimens seen limestone appeared to form the chief gangue. The Hale mine was opened in the spring of 1880. A shaft was sunk 40 feet through surface material, and entered what appears to be a large body of ore lying nearly horizontally in the limestone. A chamber 51 feet square has been excavated. On the east the ore pinches out; on the west it is cut by a dike, which forms the west wall of the pit; on the north there is a breast of ore 8 to 10 feet high. In places the room is 16 feet high, with ore still on the floor. Lying in the ore are, however, layers of limestone of various thicknesses, so that this height does not represent the thickness of good ore. Not enough work has yet been done to determine definitely the shape of the ore-body; but the probabilities are that the chamber is on the top of a shoot of ore which pitches to the northward, as in the Wood mine. Samples of the ore as it comes from the mine and after concentration contained—

e

	No. 1199.	No. 1200.
	Per cent.	*Per cent.*
Metallic iron	49.37	59.92
Phosphorus	Absent.	0.002
Titanic acid	Absent.	Absent.
Phosphorus in 100 parts iron	0.000	0.003

Sample No. 1199 is from 50 tons of "primitive" ore. Sample No. 1200 is from 100 tons of "separated" ore.

The chief gangue of the ore is calcite. Pyrite seems to be absent.

Palmer Hill is one mile and a half north of the village of Ausable Forks, Black Brook township, Clinton
f county. In it there are two large shoots of ore. The western shoot is worked by the J. J. Rogers Iron Company and the eastern one by the Peru Steel and Iron Company. Plate XXVIII shows a sketch of the workings, reduced from a plan in the office of the Peru Steel and Iron Company, which I was permitted to copy. The survey was made in 1865, and since that date the Rogers pit has been considerably deepened, and Little pit, east of the Peru Steel and Iron Company's main pit, has been excavated. This latter is in a small shoot of ore parallel to, but apparently distinct from, the main body. It is connected with the large pit by a rock drift. The bottom of the large pit is filled with water, and the only work being done in it, in June, 1881, was the removal of a large pillar of lean ore. A little ore was being mined in the cut at the entrance to the main pit north of the engine-house; but the greater part of the ore came from the Little pit.

The original workings were in an open cut along the outcrop. At a depth of about 75 feet, however, the ore

practically pinched out, excepting at the eastern end, where the "vein" was cut by a dike. This dike is about 14 a feet thick and can readily be traced over the hill. Several smaller dikes occur near the main ore; two of these are represented on the sketch. The mine was described by Dr. Emmons on pages 299 and 300 of the *Geology of the Second District*, with a diagram on page 299. Roger's pit was not opened at the date of Dr. Emmons' report.

The character of the ore from the hill is indicated by the following partial analyses:

	No. 1301.	No. 1302.	No. 1303.	No. 1304.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	44.94	66.03	33.52	63.45
Phosphorus	0.023	0.007	0.000	0.002
Phosphorus in 100 parts iron	0.053	0.010	0.000	0.003

b

Sample No. 1301 is from 6,000 tons "primitive" ore from Rogers's pit; sample No. 1302 is from 7,500 tons "separated" ore from Rogers's pit; sample No. 1303 is from 500 tons "primitive" ore, and sample No. 1304 is from 1,000 tons "separated" ore from the Peru Steel and Iron Company's pit.

The ore as it comes from the mines is a more or less intimate mixture of magnetite, feldspar, quartz, and hornblende? (or chlorite?). A portion of the ore from the Rogers pit consists almost entirely of magnetite and flesh colored feldspar, while part of it contains a considerable quantity of a soft, greenish mineral. The two varieties differ greatly in color. No pyrite nor apatite was noticed in the ore. The ore is all used in the local forges, and the iron is made into cast-steel. In the census year the J. & J. Rogers Iron Company raised 28,000 tons of ore, and the Peru Steel and Iron Company 8,670 tons. c

The *Arnold Hill* mine is about 5 miles northeast of Palmer hill, 3½ miles northwest of Clintonville, and 1½ mile west from Ferrona station on the Ausable Branch railroad; it is in Ausable township. The mine is an old one, and Dr. Emmons devotes several pages to its description. It was worked from 1864 (previous to which year it had been idle for some time) to 1881 by the Hussey & Howe Mining Company. Recently it has been bought by John A. Glidden, of Cleveland, Ohio, and is henceforth to be operated by a company under the name of the Arnold Iron Ore Company.

Seven parallel "veins" of ore have been opened upon the hill. But only three have recently been wrought. They are known as the Gray (or New Blue), the Black, and the Old Blue. These three veins are worked through one shaft. The distance from the Gray to the Old Blue varies from 65 to 80 feet; the Black is between the other two, and sometimes approaches one and sometimes the other. The Gray vein has been worked for a continuous d length of 1,700 feet, and to a depth in some places of 400 feet. The Nelson Bush mine, a recent opening on the Gray vein, is 1,800 feet beyond the northeast end of the Arnold mine, and I am told there is a strong magnetic attraction between the two pits. The strike is north 23° east, and the dip at the Arnold shaft, which is on the Black vein, is, at the surface, 71° (to the northwest); it flattens to 60° at a depth of 184 feet and to 55° at a depth of 325 feet. In width the Gray vein varies from 3 to 25 feet, exhibiting the pinch and shoot structure so common in the New Jersey mines. The line of pinch pitches at about 40° to the northeast. The Black and Old Blue veins vary in width from 3 to 7 feet. In entering the mine one is at once struck with the evenness of the walls, from which the ore separates perfectly, except, perhaps, in the "swells" in the Gray vein. The wall-rock consists usually of alternate layers of magnetite and quartz and feldspar. The magnetite layers are parallel and of various thicknesses. A hand-specimen will often represent in miniature the structure of the large deposits. Dr. Emmons e states that the "veins" are embraced in a deep-red granite. The pits described by Dr. Emmons have been abandoned, and at the present workings, so far as I observed, the walls were only occasionally granitic. The rock of the hill is mainly gneiss. The veins of ore are cut by several dikes and often slightly faulted. The ore is peculiar. In the Gray "vein" it is a granular magnetite, often "shotty", and of a black color. A hand-specimen will deflect the compass needle. Feldspar forms an essential part of the gangue; near the outcrop this was partially decomposed, giving to the ore a mottled or grayish aspect; hence the name. The ore from the Old Blue vein is a more or less coarsely granular *blue* hematite or martite; it gives a reddish-brown streak. Only the smallest pieces are lifted by the magnet, and a hand-specimen has no appreciable affect on the compass needle. The ore from the Black vein now being mined has also a blue color; but it is described by Dr. Emmons as being black. It is often coarsely granular (shotty), and the grains are readily taken up by the magnet. A hand-specimen when held near the compass deflected the needle a few degrees. The ore from both the Old Blue and the Black veins is f usually quite soft. Samples of the ores from the three veins contained—

	No. 1305.	No. 1306.	No. 1307.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	59.02	61.28	62.84
Phosphorus	0.070	0.113	0.012
Titanic acid	Absent.	Absent.	Absent.
Phosphorus in 100 parts iron	0.131	0.184	0.019

a Sample No. 1305 is from the stope in the Gray vein, second level (325 feet from surface), 300 feet north of shaft. Sample No. 1306 is from the Black vein, third level (440 feet below surface), 200 feet north of shaft. Sample No. 1307 is from Old Blue vein, second level, 400 feet south of shaft.

All the fine ore from the Gray vein, and the "dirty" portion of the fine ore from the other two veins, is separated in the usual manner, excepting that it is not previously calcined. A sample of 2,000 tons of separated ore contained—

b

	No. 1312.
	Per cent.
Metallic iron	63.96
Phosphorus	0.107
Titanic acid	Present.
Phosphorus in 100 parts iron	0.167

Under the name of "chunk" the lumps of ore from the three veins, and much of the fine ore from the Old Blue and Black veins is shipped without treatment. Two samples were collected from a pile of 4,000 tons of "chunk" ore on the railroad dock at Ferrona. Sample No. 1310 represents the larger lumps and sample No. 1311 the fine material in this pile. The samples contained—

c

	No. 1310.	No. 1311.
	Per cent.	*Per cent.*
Metallic iron	62.05	60.87
Phosphorus	0.114	0.191
Titanic acid	Absent.	Present.
Phosphorus in 100 parts iron	0.184	0.314

The *Nelson Bush* mine, as has been already stated, is situated on Arnold hill, 1,800 feet north of the Arnold mine. It is now worked by the same company as is the Arnold mine. There are two openings. In the northern pit, 100 feet deep, the vein is 25 feet wide. In the southern opening it is narrower, owing to the pinch and shoot structure of the vein. The lumps of ore are shipped without treatment, but all the fine ore is separated. Samples d from piles of the separated and of the primitive ore contained—

	No. 1308.	No 1309.
	Per cent.	*Per cent.*
Metallic iron	61.62	54.60
Phosphorus	0.102	0.344
Titanic acid	Trace.	Present.
Phosphorus in 100 parts iron	0.165	0.630

Sample No. 1308 is from 300 tons of separated ore. Sample No. 1309 is from 1,500 tons of primitive (shipping or furnace) ore.

e In the census year the Arnold Hill mine was in operation but part of the time; it produced only 1,845 tons of ore. The Nelson Bush mine was not worked.

Bowen & Signor's mine is located in the village of Williamsburg, Black Brook township, near the Saranac river. The mine is an old one, and has been worked by the present owners since 1867. In the census year it produced 7,000 tons of ore. The vein strikes north 55° east and dips at a high angle to the southeast. At the first level of the mine, about 100 feet below surface, the vein has been worked for a length of 1,600 feet, and the ore has been taken out above this level save only enough to support the roof. The mine was worked underground from the start. The width of the workable body of ore at the first level averaged 20 feet, and in some places the pit is 30 feet wide. The ore is, however, all very lean and the walls are rough and irregular, although the pit as a whole is straight. At the southwest end of the mine ore is being raised from a second level, 75 feet below the first. The f ore is all used, after being concentrated, in Bowen & Signor's forges at Redford and Russia. It takes 2½ to 3 tons of primitive ore to make 1 ton of separated ore. Samples of the ore before and after treatment contained—

	No. 1313.	No. 1314.
	Per cent.	*Per cent.*
Metallic iron	34.28	66.78
Phosphorus	0.124	0.037
Titanic acid	Absent.	Absent.
Phosphorus in 100 parts iron	0.362	0.055

Sample No. 1313 is from 400 tons primitive ore; sample No. 1314 is from 100 tons separated ore.

Tremblay's mine is situated near the south bank of the Saranac river, 1½ miles west of Clayburgh. It is owned a and worked by Peter Tremblay. In the census year it produced 1,845 tons of ore, which was all used at Tremblay's forges at Clayburgh. The pit is 150 to 200 feet in length and 75 feet deep. The ore resembles that from Bowen & Signor's mine, except that it is leaner. The ore-mass is more irregular. Much rock is picked out at the surface, and it takes at least 3 tons of the ore as it is sent to the separator to make 1 ton of separated ore. Samples of the ore contained—

	No. 1315.	No. 1316.
	Per cent.	*Per cent.*
Metallic iron	28.62	65.01
Phosphorus	0.017	0.004
Titanic acid	Absent.	Present.
Phosphorus in 100 parts iron	0.059	0.006

b

Sample No. 1315 represents the burnt ore; it was taken from the crusher. Sample No. 1316 is from a pile of separated ore.

The *Chateaugay* mine is situated near Lyon Mountain station, between the Chazy and Upper Chateaugay lakes. Lyon Mountain station is 34 miles from Plattsburgh, via the Chateaugay and Dannemora railroad. It is 2,020 feet above the lake level. The existence of this deposit of ore has long been known, and it has been worked in a small way for the supply of local forges for some years, but it is only since the completion of the railroad (in 1879) that shipments to outside furnaces have been made. In the census year 44,800 tons of ore were raised. In c the spring of 1881 the Chateaugay Ore and Iron Company was organized; it took control May 1, and since then preparations have been made for extensive developments.

The deposit of ore is a very large one, and should there continue to be a demand for ores low in phosphorus, but containing less than 50 per cent. metallic iron, the mine may develop into one of the largest in the country. The extent of the workings in June, 1881, may be briefly stated as follows: The main pit is about 850 feet long at a depth of 50 or 60 feet, and 550 feet long at a depth of 250 feet (measured on the foot-wall, which here dips to the north at an angle of 45°). At the bottom of the pit the normal width of the ore is 12 to 15 feet. The walls are a feldspathic-quartz rock, containing more or less magnetite, and great masses of feldspar, hornblende, and quartz occur through the ore, which is itself only a more or less intimate mixture of magnetite with these minerals. Gneiss is nowhere uncovered in the mine, but at the surface it is seen to form the true walls of the d "vein". In the greater part of the main pit the strike of the ore is nearly east and west; near the eastern end, however, the direction changes to about north 60° east.

Plankey's (or Richardson's) shaft is 2,100 feet northeast from "Nolan's shaft" (the middle one of the three skipways in the main pit). It is 100 feet deep, 200 feet long, and 17 feet wide. The ore dips 70° to the northwest.

Brook pit is 800 feet northeast of Plankey's shaft; it is a small open cut.

Williams' shaft is 3,600 feet from Brook pit and 6,500 feet from Nolan's shaft. This shaft was filled with water when visited. It is said to be 100 feet deep. The dip at the surface is 69° (to the northwest), and the horizontal width at the bottom of the cribbing is 22 feet. Much of the rock on the dump is gray micaceous gneiss.

A pit has been opened about 1½ miles northeast of Williams' shaft, and apparently on the same vein.

Between Williams' and Nolan's shafts there is a continuous line of strong magnetic attraction, and a second e line south of the first is readily traced out. Near the bend, at the main pit, the attraction on the south vein is very strong, but the vein has nowhere been opened upon.

About 100 feet west of the main pit the Hammond pit is down to a depth of 30 or 40 feet, and several test pits have been sunk to the ledge, a short distance west of the Hammond pit. Beyond these there seems to be very little magnetic attraction.

The material from the mine is sorted into, first, rock; second, separating ore; third, shipping or furnace ore. The present output (June, 1881) is 48 to 54 car-loads (equal to about 300 tons) of shipping ore each 24 hours, and about an equal amount of separating ore. It takes about 3 tons of the latter to make 1 ton of separated ore. Samples of these ores contained—

	No. 1317.	No. 1318.	No. 1319.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	45.21	66.00	62.78
Phosphorus	0.011	0.003	0.103
Titanic acid	Absent.	Present.	Present.
Phosphorus in 100 parts iron	0.024	0.005	0.164

f

Sample No. 1317 is from 22 car-loads (about 120 tons) of furnace ore ready for shipment. Samples Nos. 1318 and 1319 are from 100 tons of separated ore at No. 2 separator, and 150 tons of separated ore at No. 3 separator, respectively.

a *Mine* 81, so called from the number of the lot on which it is situated, is owned and operated by the Chateaugay Ore and Iron Company. It is about a mile and a half west of Nolan's shaft, and seems to be on the same belt if not on the same vein of ore as the Chateaugay mine. There are two pits. The western pit is 100 feet deep, 226 feet long, and 16 to 19 feet wide. The strike of the ore is north 38° east, and its dip is 80° to the southeast. This pit was opened in the autumn of 1878. The eastern pit is 400 feet from the western one; it is 70 feet deep and 21 feet wide; it was opened in May, 1880. The ore is similar to the Chateaugay ore. It is teamed 1½ miles to the separator, and thence to the forges on the Saranac river. It takes fully 3 tons of primitive ore to make one ton of separated ore. The character of the ore is shown below:

b

	No. 1320.	No. 1321.
	Per cent.	*Per cent.*
Metallic iron	65.14	34.81
Phosphorus	0.017	0.041
Titanic acid	Present.	Absent.
Phosphorus in 100 parts iron	0.026	0.118

Sample No. 1320 is from 150 tons of separated ore. Sample No. 1321 is from 300 tons of primitive ore.

"81" completes the list of working mines in the Lake Champlain region.

Many other "veins" are mentioned by Dr. Emmons, both in Clinton and Essex counties, but for one reason or another they are not at present worked, and were therefore not sampled.

c

FRANKLIN AND SAINT LAWRENCE COUNTIES.

In Franklin county Dr. Emmons notes several localities where magnetic ore was being mined at the date of his report. These mines are now idle, however, and no ore was produced in the county in the census year. Magnetic ore is known to exist in the eastern part of Saint Lawrence county, but this district is still an almost unbroken wilderness, and little mining has yet been done. During the winter of 1880 some ore was raised near Jayville, in Fine township. (*a*) The locality was not visited, but a sample was collected from a pile of 500 tons of the ore at the Alpine furnace. The sample contained—

d

	No. 1345.
	Per cent.
Metallic iron	56.72
Phosphorus	0.009
Titanic acid	Absent.
Phosphorus in 100 parts iron	0.016

The ore is a rich-looking magnetite and contains no pyrite.

II. LIMONITES.

e

RICHMOND COUNTY (STATEN ISLAND).

Beds of limonite have long been worked in the northern part of Staten Island, in Middletown, Castleton, and Edgewater townships. All the deposits visited were underlaid with serpentine, and they are believed to be confined to the belt of this rock. Professor Mather says, in speaking of these deposits: (*b*) "The ore-beds, where I have seen them, are directly contiguous to the serpentine rock, which contains an abundance of carbonate and hydrate of magnesia, and which seems to have performed the same office in the deposition of the ore as the limestone-beds of Columbia and Dutchess counties."

In a paper on the "Geology of Richmond county", in the *School of Mines Quarterly* (New York, May, 1881), Mr. N. L. Britton, after stating that deposits of limonite are found resting directly on the "serpentine or talcose rocks",

f remarks that these [the deposits of limonite] "have probably had their origin in the deposition of the material composing them from the waters of thermal springs, which have come to the surface through crevices in the serpentine; the iron in the solutions was probably in the form of carbonate, which on reaching the surface became oxidized by contact with the atmosphere, and was thrown out of solution and deposited as the hydrated sesquioxide as we now find it". Mr. Britton observed magnetic sand in one ore-bed on Todt hill, "which was probably washed in mechanically while the hydrated oxide was being deposited from solution."

The deposits are superficial, and their lateral extent is limited to a few hundred feet in any direction. They vary in thickness from a few inches to 12 feet or more, and, with the exception of those on Todt hill (New Dorp and Towle mines), which are east of the terminal moraine, the beds are covered with several feet of glacial drift.

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a See Fig. 42, p. 141.

b *Geology First District*, p. 489.

The ore occurs associated with yellow clay and yellow and red ocher. Analyses show the presence in the ore of over 1½ per cent. of sesquioxide of chromium, besides small amounts of sulphide of nickel and cobalt. Its contents in phosphorus is, as a rule, comparatively low.

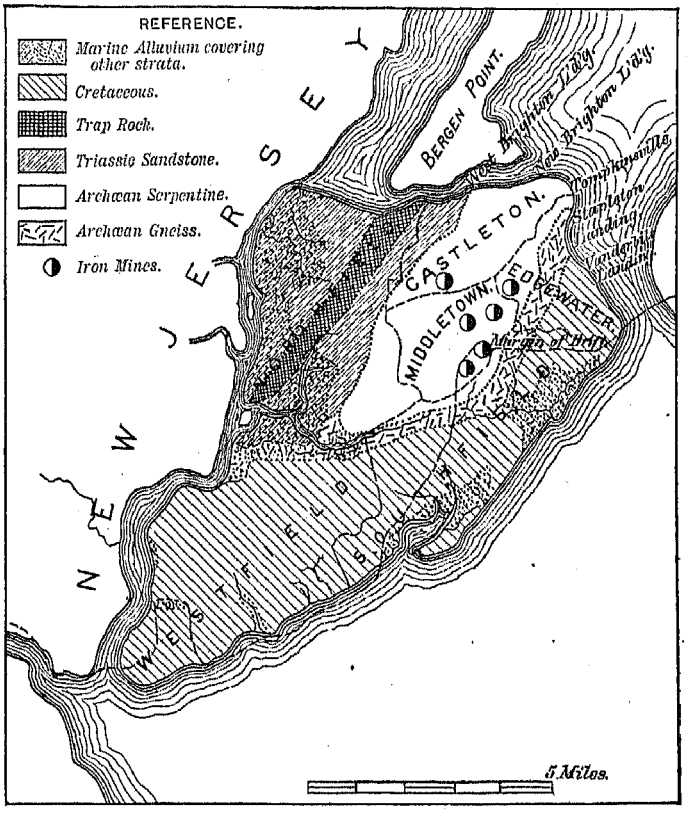

FIG. 29.—GEOLOGICAL MAP OF STATEN ISLAND. From map by N. L. Britton in *School of Mines Quarterly*, May, 1881.

Much of the ore is in small pieces and is separated from its gangue by washing. The larger lumps are picked out by hand. Besides the spongy-form or cavernous ore, common in all beds of limonite, there occurs in some of the

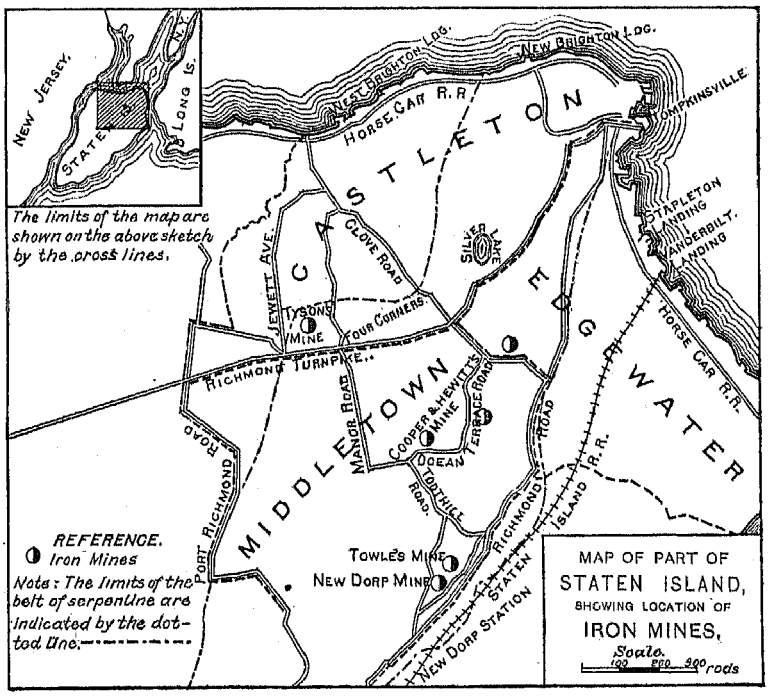

FIG. 30.

beds a peculiar oölitic ore, consisting of concentric spherical concretions of limonite imbedded in a ferruginous clayey matrix. The concretions vary from the size of a buckshot to that of a large "marble". The ore is locally known as "shot-ore".

The location of the beds worked in the census year is shown on Figs. 29 and 30.

a The *New Dorp* mine is situated on the east side of the Todt Hill road, in Middletown township, and about 1 mile north of New Dorp station, on the Staten Island railroad. The mine is near the top of a spur of Todt hill, perhaps 75 or 100 feet above the level of the road. The ore lies nearly horizontally, and is separated from the serpentine rock by a few inches of ocher. A breast of ore 4 or 5 feet thick is exposed along the north side of the pit. At the west end of this breast the ore is covered with but an inch or two of soil, but toward the east the surface material thickens (see sections on Fig. 31).

To the south and west of the pit the hill slopes quite abruptly and the ore appears to have been all removed by erosion; on the north and east the surface, however, is level or slightly rising, and in these directions the ore probably extends for some distance. The ore is washed in an inclined sluice-box. A sample taken from a pile of

b 3,000 tons of washed ore yielded on complete analysis—

	No. 714.
	Per cent.
Sulphur	0.391
Phosphorus	0.059
Iron, metallic	39.72
Silica	14.19
Iron, protoxide	0.55
Iron, peroxide	55.95
c Alumina	8.59
Manganese, protoxide	0.52
Chromium sesquioxide	1.91
Lime	0.18
Magnesia	3.60
Iron, disulphide	0.293
Nickel, sulphide	0.55
Cobalt, sulphide	0.17
Potassa	0.19
Soda	0.40
Carbonic acid	0.22

	No. 714.
	Per cent.
Phosphoric acid	0.135
Carbon in carbonaceous matter	0.13
Hygroscopic water	2.21
Water of composition	10.20
Total	99.988
Insoluble silicious matter	21.26
Silica	14.19
Alumina (with a trace of oxide of iron)	3.47
Magnesia	2.92
Potassa	0.03
Soda	0.07
Phosphoric acid	0.01
Chromium, sesquioxide	0.68
Total	21.37

d Samples were also taken from a pile of about 100 tons of "rock-ore" which had been accumulating the same length of time as the 3,000 tons of washed ore. These samples contained—

	No. 712.	No. 713.
	Per cent.	*Per cent.*
Metallic iron	29.89	47.21
Phosphorus	0.107	0.043
Titanic acid	Present.	Present.
Manganese	.....	Present.
e Phosphorus in 100 parts iron	0.358	0.091

Sample No. 712 consisted of chippings from selected pieces of "shot-ore"; sample No. 713 represents an average of the pile of rock-ore *exclusive* of the shot-ore, which latter formed but a small proportion of the pile.

The New Dorp mine is owned by S. B. Schieffeln. It was opened in March, 1880, but no ore was shipped before June. David Tyson, jr., is the operator.

Two hundred and fifty feet northeast of the mine above described is an opening about 75 feet long by 50 feet wide, from which 6,720 tons of ore were dug in the summer and autumn of 1879 by T. D. O'Brien. The mine is owned by Jeremiah Towle, and is designated the *Towle* mine on the map. Operations were suspended at the close of canal navigation, and the mine was idle when visited. The ore was not sampled, but a section of the bed at the north end of the pit is shown at E F, Fig. 31.

f *Tyson's Four Corners* mine is situated near the village of Four Corners, on the old Richmond turnpike. The mine is in the town of Castleton, and is about 2 miles by road from the dock at West Brighton. The old workings consisted of an open pit several hundred feet in length, which extended nearly to Jewett's avenue. This pit has been abandoned, and the present operations are south of the southeast end of it, under the apple orchard (see sketch, Fig. 32). Work was begun at this point in March, 1880. The ore is covered with 9 feet of clay and gravel, and after cutting a trench into the side of the hill for about 50 feet, exposing a breast of ore 6 feet in height on the west, a tunnel was started westward, and all subsequent mining has been done underground. The main drift is about 100 feet long, and is all in ore. From this other drifts have been driven at right-angles to it. The tops of

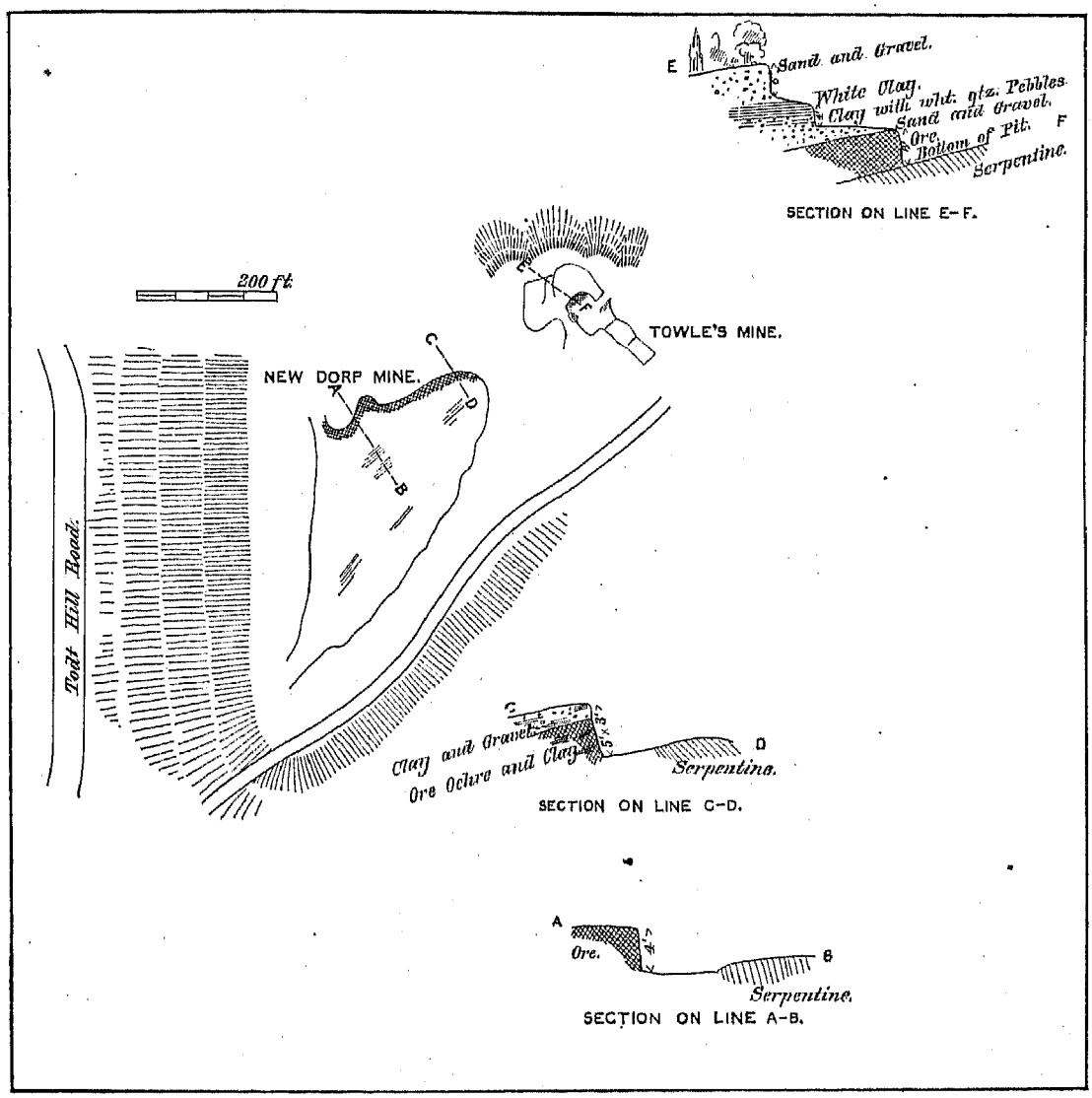

FIG. 31.—SKETCH OF THE NEW DORP AND TOWLE MINES, STATEN ISLAND, NEW YORK.

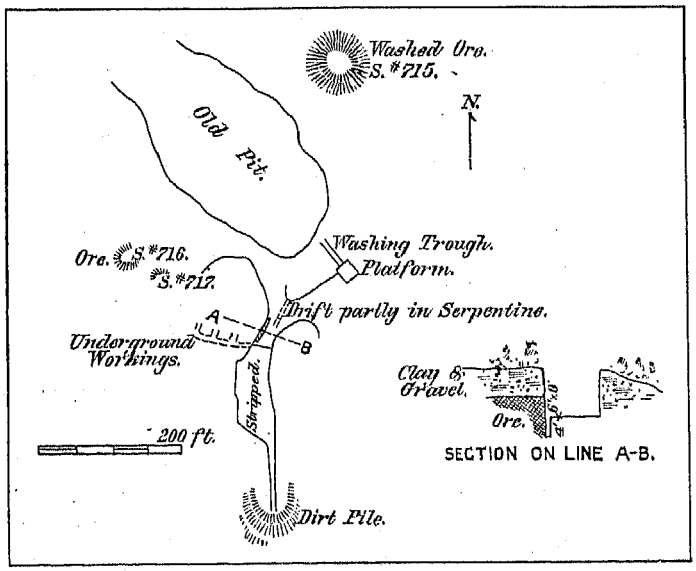

FIG. 32.—SKETCH OF TYSON'S MINE, FOUR CORNERS, STATEN ISLAND, NEW YORK.

a the drifts are cut in arch form, and scarcely any timbering is required. A trench along the west side of the cut is bottomed in ore, so that at this point the bed of ore is at least 10 feet thick (see section). The following analyses show the quality of the ore:

	No. 715.	No. 716.
	Per cent.	*Per cent.*
Metallic iron	48.74	41.64
Phosphorus	0.079	0.080
Manganese	Present.	.....
Titanic acid	Present.	Present.
Phosphorus in 100 parts iron	0.162	0.192

b

Sample No. 715 is from a pile of 500 tons of washed ore; sample No. 716 is from a pile of a few tons of rock ore, principally compact or cavernous limonite, but containing, also, a little "shot-ore".

Pockets of an almost black, earthy substance, called by the miner's "manganese", occur in the ore. Believing this to be more valuable than the iron ore, Mr. Tyson has had some of it placed in a separate pile. A sample taken from about 25 tons contained—

	No. 717.
	Per cent.
Metallic iron	51.20
Phosphorus	0.050
Metallic manganese	1.16
Chromium	Present.
Phosphorus in 100 parts iron	0.098

c

The analysis shows this material to be of no value except as an ore of iron.

Red and yellow ochers of apparently good quality are found here in sufficiently large quantities to be saved separately in mining.

d The mine is owned and operated by David Tyson, jr. About 200 tons of ore were raised between March and June, 1880. The mine was idle in 1879.

Cooper & Hewitt's mine is located near the Ocean Terrace road. The mine was idle when visited (August 6, 1881), but had been worked earlier in the summer; 1,344 tons of ore were raised from it in the census year. The size and shape of the pit is shown on the sketch (Fig. 33). The ore was screened instead of being washed. A sample from a pile of about 50 tons of screened ore contained—

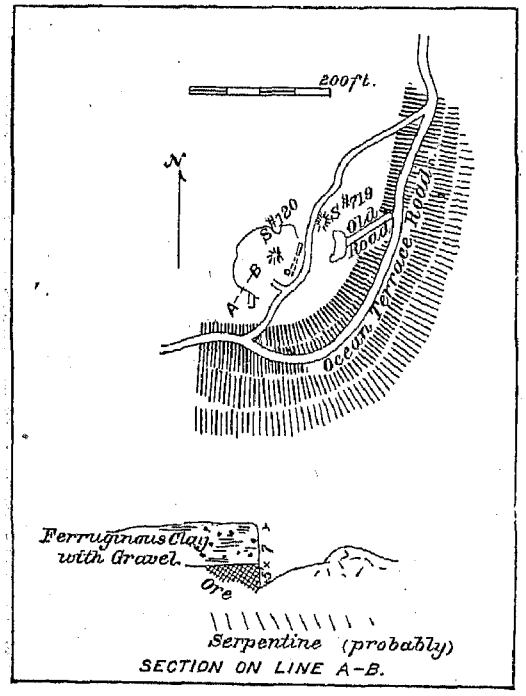

FIG. 33.—SKETCH OF COOPER & HEWITT'S MINE, STATEN ISLAND, NEW YORK.

e

	No. 719.
	Per cent.
Metallic iron	38.86
Phosphorus	0.022
Manganese	Present.
Phosphorus in 100 parts iron	0.057

If this ore was properly washed it would probably run 45 per cent. in metallic iron.

A sample was also taken here of a variety of compact, hard, and very dark-colored ore, which seems to occur in some quantities. The sample contained—

f

	No. 720.
	Per cent.
Metallic iron	51.57
Phosphorus	0.003
Manganese	Present.
Phosphorus in 100 parts iron	0.006

There are numerous old openings on the hill east of the above-mentioned pit, from which a large amount of ore has probably been taken. At one of these openings, about a half mile east of Cooper & Hewitt's mine, a little

ore was raised in the spring of 1880. When visited no work was being done and all the ore had been carted away. a The ore was screened. A sample of the fine screenings (refuse) contained—

	No. 718.
	Per cent.
Metallic iron	31.81
Phosphorus	0.048
Phosphorus in 100 parts iron	0.151

In Edgewater township, near the Clove road, some work was recently done at *Snell's* opening. The mine was b idle when visited and the ore was not sampled.

ORANGE COUNTY.

A deposit of limonite belonging to Vanduzer and Townsend, located in Cornwall township, was reopened in December, 1879, by Richard George. It was worked for four months and produced 672 tons of ore. This bed was described, under the name of the Canterbury ore-bed, by Professor Mather, (*a*) and it differs from the deposits in Dutchess and Columbia counties in being associated with the Helderberg limestone. Many fossils occur in the ore. The mine was not visited, but a sample was taken from a pile of 150 tons of the ore at the West Point furnace. It yielded on analysis— c

	No. 728.
	Per cent.
Metallic iron	28.57
Phosphorus	0.240
Manganese	Present.
Phosphorus in 100 parts iron	0.840

DUTCHESS AND COLUMBIA COUNTIES.

The belt of limonite ores east of the Hudson river extends from the southern part of Dutchess county d northward through Columbia county, New York, the northeastern part of Litchfield county, Connecticut, the western part of Berkshire county, Massachusetts, well into the state of Vermont.

The geological relations of these ore-deposits have recently been studied by Professor Dana in connection with the study of the "great limestone belt". Some of his conclusions may be briefly stated as follows: (*b*) Throughout the great limestone area the ore-beds are alike in the nature of the ore, its mode of aggregation, and its association with yellow ocher and clays. Manganese is generally present in the deposits, but is more abundant in the beds in Vermont than in those farther south. The beds occur in the vicinity of all the rocks of the limestone area—the limestone, hydromica slate, clay slate, mica-schist, gneiss, and quartzite. But they are most abundant where the schist is the hydromica slate. The deposits are "alike in their interrupted occurrence and varying depths—even many miles often intervening between those of workable value and all depths existing from zero to 150 feet or e more". The ore has been derived principally from the oxidation *in place* of carbonate of iron and ferriferous limestone, and to some extent, also, from the iron-bearing minerals of the schists which were near the iron carbonate. These schists have been changed to soft clay, probably largely through the destructive influence of the carbonic acid set free through the oxidation of the iron in the ferrous carbonate. Silicates, like garnet, black mica, and chlorite, would yield to the same agent, and so give up their iron for oxidation. Sulphuric acid would also have aided in the destruction wherever any pyrite existed. "But the nearly total absence from the ore of sulphur (seldom over one-tenth of one per cent.) appears to be evidence that pyrite played a very subordinate part in the production of the limonite."(*c*) "The beds all show that their formation was not dependent on erosion or transportation, and that the change to limonite required only the free access of air and moisture (with the traces of carbonic acid they ordinarily contain) to the iron-bearing minerals."

That surface drainage, in one way or another, played an important part in the production of these deposits of f ore is evident from the fact that all the large beds at least occur in valleys or on the sides of valleys. Professor Dana remarks: "From some of the mines it appears that the best positions for the making of deep beds was off the mouths of valleys or near slopes that carried down the rains for underground use." He adds: "An iron-bearing carbonate would suffer rapid destruction under these circumstances."

As bearing directly upon the question of the derivation of these ores, I may be permitted to point out that Professor Dana appears to be in error regarding their contents in sulphur. While the percentage of sulphur in

a *Geology First District*, p. 491.

b *Geology of Vermont and Berkshire:* Limonite ore-beds of the limestone region. *Amer. Jour.*, III, xiv (1877), p. 132.

c *Loc. cit.*, p. 139.

a the ores is as a rule low, there are a number of localities where it is much greater than one-tenth of 1 per cent. For instance, in a paper on the Hematite Ore Mines and Blast-Furnaces East of the Hudson River, (*a*) Mr. James F. Lewis gives a table of analyses in which ore from the Amenia mine is credited with 0.34 per cent. sulphur; ore from the Manhattan mine with 0.69 per cent. sulphur; ore from the Riga mine with 0.68 per cent. sulphur, etc. It is to be regretted that time permitted the determination of sulphur in only a few of the samples collected for the census.

Commercially the ore in these mines is known as "wash-ore" and "rock-ore". By "wash-ore" is meant a mixture of small pieces of limonite, ocher, and clay, with sufficient of the former to pay for separating it from the other materials. The separation is effected by washing in inclined troughs or revolving cylindrical sieves.(*b*) The b latter method is the most thorough and is the one now usually employed. After washing, the ore is known as washed ore. By "rock-ore" is understood those pieces which can be picked out in mining and shipped without washing. The amount of rock-ore varies in the different beds, but it is usually (comparatively) small. At some mines all the ore is washed. The lumps of ore are generally cavernous or spongiform, but botryoidal, mammillary, and stalactitic varieties also occur, especially on the inner surface of "bombs". Many very beautiful specie mens are obtained from some of the mines, particularly from the Brookpit mine, in Salisbury, Connecticut, and the Manhattan mine, in Amenia, New York.

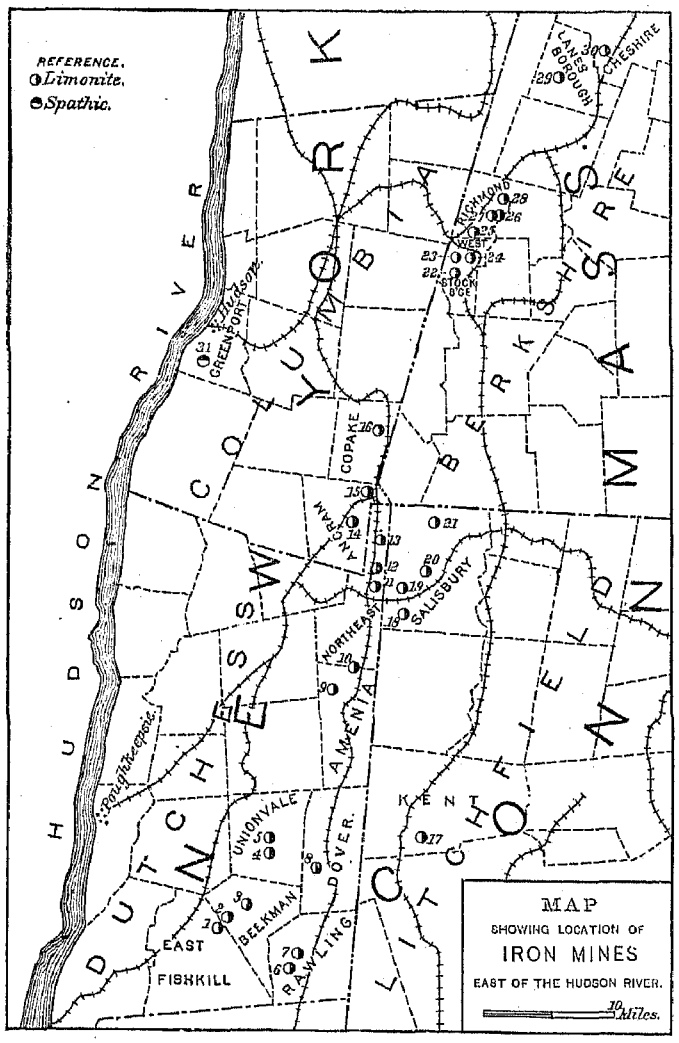

FIG. 34.

In New York and Connecticut the method of exploitation usually employed is by stripping the surface material (drift) from off the ore and digging the latter in open pits. In Massachusetts the open-cut mining has been nearly entirely superseded by underground work in shafts and levels.

DUTCHESS COUNTY.

d There are two belts of ore-beds in Dutchess county:

First. A belt extending along the valley of the Fishkill creek in a northeasterly direction from near the village of East Fishkill to the central part of Unionvale township.

Second. A belt extending along the valley through which runs the New York and Harlem railroad, from Pawling station, in the southeastern part of Dutchess county, to Hillsdale, in Columbia county. The direction of this belt is nearly due north and south.

e Outside the limits of the belts above described ore has been discovered on Stissing mountain, in Stanford township, and in Washington and Milan townships. No developments have been made, however, and the localities were not visited.

The location of the mines worked in the census year is shown on the map (Fig. 34).

FISHKILL CREEK BELT.

The ore-beds south and west of the village of East Fishkill have been long idle. In ascending the valley, the first working mine met with is the *Fishkill* mine (1).(*c*) This is located on the south shore of Sylvan lake, near Sylvan f Lake station, on the Clove branch of the Dutchess and Columbia railroad, 16 miles from Dutchess junction, the Hudson river terminus of the railroad. The mine is owned by Albert Tower, and is operated by the Poughkeepsie Iron Company; the ore is all used at Poughkeepsie; the pit is 90 feet deep; the ore is covered with an average of about 40 feet of surface material; no rock was seen in the mine, but Dr. Beck, (*d*) at the time of his visit (1837), found layers of decomposed slate alternating with the ore; limestone occurs west of the pit. From two-thirds to three-quarters of the material raised from the mine, exclusive of the "stripping", is shipped as ore. Very little rock-ore is found. A sample from 7 car-loads of washed ore yielded, on complete analysis—

---

a *Trans. Amer. Min. Eng.*, v (1877), p. 235.

b The Thomas washer, so popular in Pennsylvania, is not used east of the Hudson river (1881).

c The numbers refer to the map, Fig. 34.

d *Natural History of New York*, iv, p. 492.

a

	No. 755.		No. 755.
	Per cent.		*Per cent.*
Sulphur	0.143	Phosphoric acid	0.167
Phosphorus	0.073	Carbon in carbonaceous matter	0.06
Iron, metallic	40.92	Hygroscopic water	0.87
Phosphorus in 100 parts iron	0.179	Water of composition	0.48
		Total	100.317
Silica	24.08		
Iron, protoxide	0.25	Per cent. of insoluble silicious matter	27.21
Iron, peroxide	57.99		
Alumina	3.82		
Manganese, protoxide	0.94	Silica	24.68
Lime	1.13	Alumina (with a trace of oxide of iron)	1.94
Magnesia	0.41	Lime	0.27
Iron, disulphide	0.270	Magnesia	0.23
Carbonic acid	0.25	Total	27.12

b

In the census year 18,346 tons of ore were raised from the mine.

Adjoining the Fishkill mine on the northeast, and really forming part of the same pit, is the *Sylvan Lake* mine (2), owned and worked by the Sylvan Lake Ore and Iron Company. Part of the ore is shipped to Burden & Sons, Troy, and the remainder is used at the Clove Valley furnaces. When smelted alone with charcoal the product is car-wheel iron. The pit is about 145 feet deep. The ore-bearing stratum is covered with 45 feet of "stripping". c Nearly the whole of the output passes through the washers, and about 50 per cent. of the material raised from the bottom of the pit goes to the mud-dam, although this varies greatly in the different parts of the bed. Sample No. 753 was collected from five car-loads of washed ore, and sample No. 754 from a pile of 40 tons of rock-ore. These samples contained—

	No. 753.	No. 754.
	Per cent.	*Per cent.*
Metallic iron	48.48	47.05
Phosphorus	0.050	0.041
Manganese	Present.	Present.
Phosphorus in 100 parts iron	0.104	0.087

d

In the census year 16,096 tons of ore were raised. The total product is estimated at 112,000 tons. The mine was opened in 1868.

West of the Fishkill and Sylvan Lake mines are two pits belonging to the Dutchess Ore Company, and known as the Horton mine. The mine was opened in 1872. It was idle during the census year.

Explorations made just north of the lake have recently discovered a bed of ore, but it has not as yet been developed.

The *Beekman* mine (3) is situated at Beekmanville, about 2 miles northeast of Sylvan lake, and one-eighth of a mile from the railroad. It is owned by Albert Tower, and is worked by the Poughkeepsie Iron Company. The e ore is shipped to Poughkeepsie. The pit is 65 feet deep. The stripping varies in thickness from 2 to 20 feet. Limestone outcrops a few rods northwest of the pit and in places forms the side of the pit itself. Usually, however, clay and ocher lie between the ore and the limestone. A little rock-ore is shipped from the mine, but the greater portion of the product is washed. Samples taken from a car-load of washed ore and a pile of a few tons of rock-ore yielded on partial analysis—

	No. 751.	No. 752.
	Per cent.	*Per cent.*
Metallic iron	20.50	51.85
Phosphorus	0.009	0.050
Manganese	Present.	Present.
Phosphorus in 100 parts iron	0.234	0.096

f

Sample No. 751 represents the washed ore, and sample No. 752 the rock-ore.

The low percentage of iron in sample No. 751 is to be accounted for from the fact that the ore had not been thoroughly washed, owing to a temporary scarcity of water.

In the census year the Beekman mine produced 7,364 tons of ore.

The *Clove* mine (4) is situated in the south-central part of Unionvale township, about 4 miles in a direct line northeast from Beekmanville, and 3 miles from the terminus of the Clove branch of the Dutchess and Columbia

a railroad. The mine is owned and worked by the Fallkill Iron Company. The ore is used in the company's furnaces at Poughkeepsie. The ore lies in limestone, which forms the eastern wall of the pit; it has been uncovered, too, at several points in the bottom of the pit. On the west no rock has yet been met with in the main pit; but in a small pit north of it (from which all the ore has been taken) limestone occurs on both walls. The main pit is about 600 feet long, and, in the northern end, where ore is now being dug, 90 feet deep. At this point 35 feet of stripping has to be removed. Very little rock-ore is obtained. A sample from 150 tons of washed ore contained—

	No. 758.
	Per cent.
Metallic iron	34.18
Phosphorus	0.049
Phosphorus in 100 parts iron	0.143

b

The ore was badly washed, owing to lack of water.

In the census year 4,516 tons of ore were produced.

A few rods northeast of the Clove mine is the *Clove Spring* mine (5), owned and operated by the "Clove Spring Iron Works". The ore is used at Clove Valley, making No. 1 and No. 2 foundery iron when mixed with Lake Champlain ores and smelted with anthracite, and car-wheel iron when smelted alone with charcoal. The present c stope is at the south end of the pit, at this point 56 feet deep. A section at the stope shows a breast of ore 33 feet 10 inches high on the east and 23 feet high on the west side of the pit, with the upper surface of the ore pitching to the west at an angle of 15°. Immediately overlying the ore is a bed of hard, blue clay 21 feet thick, near the western side of the pit, but thinning down against the ore toward the east. The upper surface of the clay is level. Above the clay is a mixture of horizontally stratified clay and gravel, the gravel gradually preponderating toward grass-roots. The surface slopes gradually to the west. Limestone forms the eastern wall of the pit. No rock was exposed on the western wall.

Of the material spoken of above as ore, about one-third is lost in washing. More rock-ore is found here than at any other mine on this belt, the proportion of rock to washed ore being about as 1 to 4. Samples were taken from piles of 350 tons of rock-ore and 500 tons of washed ore at the furnace. The samples contained—

d

	No. 756.	No. 757.
	Per cent.	*Per cent.*
Metallic iron	48.74	45.22
Phosphorus	0.083	0.128
Phosphorus in 100 parts iron	0.170	0.283

Sample No. 756 is the rock-ore; sample No. 757, the washed ore.

From July, 1871, to May 30, 1880, the mine produced 107,260 tons of ore. The output in the census year was e 19,400 tons.

NEW YORK AND HARLEM RAILROAD BELT.

The southernmost mine in this belt is the *Valley Pond* mine (6), situated in Pawling township, at the lower end of Little pond. The mine is owned by Stephen O. Davis and is operated by Cornelius J. Haight. Mining was begun in the spring of 1880, but no ore was raised before the close of the census year. Little pond is on the top of a ridge of highly metamorphosed garnetiferous and micaceous schists and gneisses,(a) and the ore-bed lies on a narrow valley or gulch extending south from the pond. It was first discovered about 400 feet from the pond. In August the bed had been uncovered by a trench 10 feet wide for a length of about 75 feet. Both sides of this trench are ore; the width of the deposit had not been determined. At the southern end of the trench there is about 6 feet of gravel and clay above the ore. Sample No. 749 was taken from 25 tons of washed ore and sample f No. 750 from 50 tons of rock-ore. The samples contained—

	No. 749.	No. 750.
	Per cent.	*Per cent.*
Metallic iron	48.93	48.70
Phosphorus	0.165	0.158
Phosphorus in 100 parts iron	0.337	0.324

a "Taconic". Dana, *Am. Journ.*, III, XVII, p. 485.

The *Pawling* mine (7), also in Pawling township, is located at the foot of the mountain, 2 miles west of Pawling station, on the Harlem railroad. It is owned by the "National Mining Company of Pawling" and B. A. Sill, and is worked by the company. In the census year 7,280 tons of ore were mined. The pit is about 400 feet long, 50 feet wide, and 45 feet deep (see Fig. 35). On the west side of the pit is a ridge of micaceous gneiss,(*a*) which dips to the east at an angle of about 60°. The east side shows 25 feet of ore, overlaid by 20 feet of clay and gravel. The bottom of the pit is ore. The ore pitches eastward underneath a swamp. Beyond the swamp there is a limestone

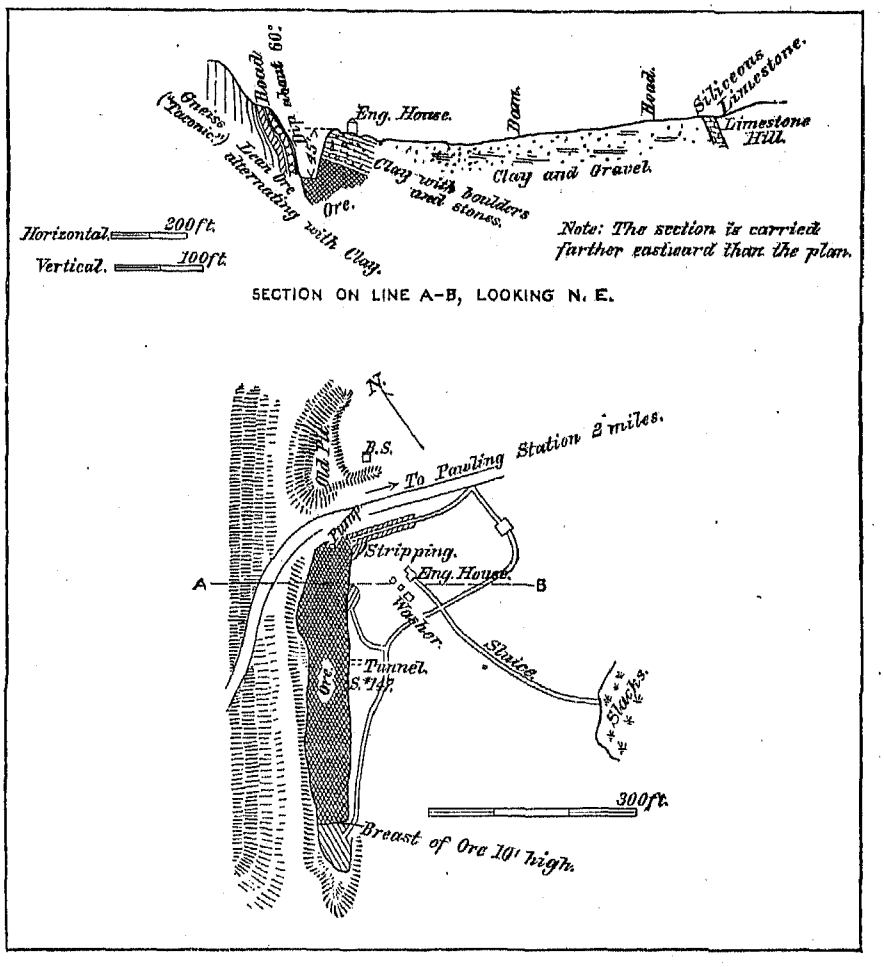

FIG. 35.—SKETCH OF THE PAWLING MINE, DUTCHESS COUNTY, NEW YORK.

ridge. Two samples of ore were collected from the mine. Sample No. 747 was taken from the sides of a drift about 20 feet long, which had been driven eastward from the bottom of the pit. Sample No. 748 is from a car-load of washed ore. The samples contained—

	No. 747.	No. 748.
	Per cent.	*Per cent.*
Metallic iron	43.22	47.12
Phosphorus	0.113	0.137
Phosphorus in 100 parts iron	0.261	0.291

The *Dover* mine (also known as the "White" or "Foss" mine) (8), is in Dover township, about 1½ miles from Dover furnace, a station on the Harlem railroad. It is owned and worked by the South Boston Iron Company. In the census year 8,960 tons of ore were produced. The mine is located in a gulch between two spurs of the garnetiferous mica-slate ridge which bounds the Dover valley on the west. No limestone occurs near the ore. The bed was originally worked in open cut, but the ore is now exploited by underground mining. The shaft is 50 feet deep; the total length of the drifts is about 800 feet. The drifts are mainly in a dense clay of various colors, but showing no lines of stratification. The ore lies in irregular bunches rather than in bands in this clay. The ore is

a "Taconic", Dana, *loc. cit.*

a teamed to near the foot of the mountain, where it is washed in an inclined sluice-box, the washed ore passing directly onto the cars. The washing is imperfect, and at some of the furnaces where the ore is used it is rewashed in a Bradford washer. The following analyses show the character of the ore:

	No. 759.	No. 760.
	Per cent.	*Per cent.*
Metallic iron	37.75	52.50
Phosphorus	0.203	0.743
Phosphorus in 100 parts iron	0.538	1.415

b

Sample No. 759 represents an average of three car-loads of washed ore. Sample No. 760 is a special sample, consisting of selected chippings of a variety of very dark-colored, crystallized (fibrous) limonite.

The *Gridley* mine (9) is near Amenia post-office, Amenia township. It is owned and worked by N. Gridley & Son. The ore is used at the Gridley furnace at Wassaic. In the census year 6,160 tons of ore were produced. The ore is all washed. A sample from a pile of 200 tons of washed ore yielded on complete analysis—

	No. 762.		No. 762.
	Per cent.		*Per cent.*
Sulphur	0.152	Phosphoric acid	0.959
Phosphorus	0.413	Carbon in carbonaceous matter	0.08
Iron, metallic	48.99	Hygroscopic water	0.51
Phosphorus in 100 parts iron	0.843	Water of composition	9.76
		Total	100.286
Silica	11.94		
Iron, protoxide	0.30		
Iron, peroxide	67.77	Insoluble silicious matter	15.44
Alumina	4.10		
Manganese, protoxide	0.05		
Lime	1.60	Silica	11.94
Magnesia	0.48	Alumina (with trace of oxide of iron)	2.15
Iron, disulphide	0.280	Lime	0.32
Potassa	1.12	Magnesia	0.20
Soda	0.34	Potassa	0.02
Carbonic acid	0.34	Soda	0.10
Sulphuric acid	0.06	Total	15.63

c

d

Carbonate of iron occurs in bunches or "horses" in the limonite. It is called by the miners "white horse" or "dead head". When freshly broken it has a gray color, but a lump will, on exposure, soon become coated with peroxide of iron. A sample was carefully selected from a pile of several hundred tons of this material which had been thrown to one side as unsalable. The chippings were, as far as possible, only of the unaltered carbonate. The sample contained—

	No. 763.
	Per cent.
Metallic iron	42.94
Phosphorus	0.053
Phosphorus in 100 parts iron	0.123

e

Adjoining the Gridley pit, on the north, is the *Amenia* mine (10), owned and operated by the Amenia Iron Company. The mine is the oldest one in the county; it was opened about the year 1760. From 1866 to 1880 it produced 172,480 tons of ore. In the census year 12,320 tons were mined. The ore is used principally in the neighboring charcoal furnaces, but partly, also, in the anthracite furnaces on the Hudson river. The sketch (Fig. 36) shows the approximate dimensions of the pit. The ore, as is seen from the section, lies near the contact of limestone and mica slate. A sample from a few tons of the washed ore contained—

f

	No. 761.
	Per cent.
Metallic iron	48.28
Phosphorus	0.092
Phosphorus in 100 parts iron	0.190

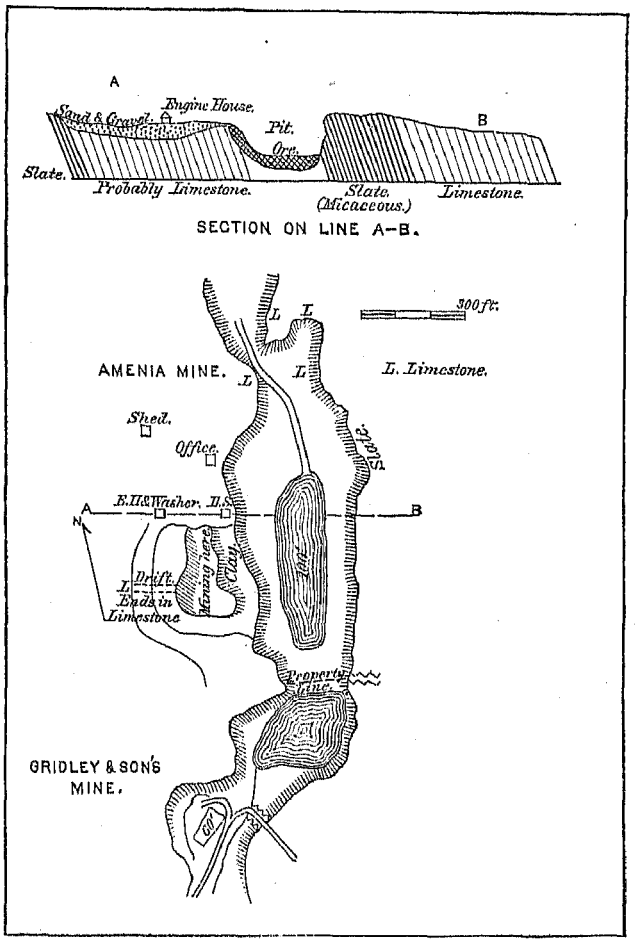

FIG. 36.—SKETCH OF THE AMENIA MINE, DUTCHESS COUNTY, NEW YORK.

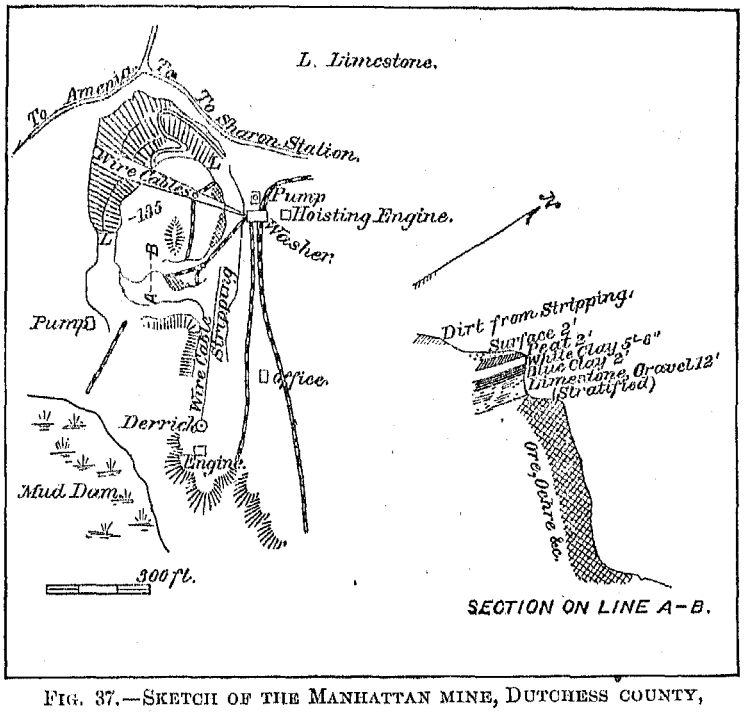

FIG. 37.—SKETCH OF THE MANHATTAN MINE, DUTCHESS COUNTY, NEW YORK.

a The *Manhattan* mine (11) is located at Sharon station, near the northern boundary line of Amenia township. It is owned and worked by the Manhattan Mining Company. A spur-track from the Harlem railroad runs to the washer, and everything is arranged for the convenient handling of the ore. In the census year the output was 21,280 tons, an amount not equaled by any other limonite mine east of the Hudson river. As shown by the sketch (Fig. 37), the pit is nearly circular in shape, and is about 135 feet deep. The ore pitches to the southwest, underneath a swamp. Limestone is exposed in several places in the pit, but no slate was seen. The ore is covered with from 10 to 40 feet of stripping. In washing there is a loss of from 30 to 75 per cent. of the material raised from the pit as ore. Many beautiful specimens of crystallized ore are found at this mine. The samples collected here contained—

b

	No. 764.	No. 765.
	Per cent.	*Per cent.*
Metallic iron	47.77	50.13
Phosphorus	0.086	0.038
Manganese, protoxide	.....	1.03
Phosphorus in 100 parts iron	0.180	0.076

Sample No. 764 is from 3 car-loads of washed ore; sample No. 765 consists of selected chippings of a crystallized ore, with jet-black, highly-polished surface.

The *Maltby* mine (12) is near Spencer's corners, Northeast township, about 6 miles north of Sharon station, and is owned by Caleb S. Maltby. It is an old mine, having been opened in the last century. The ore is used in the Phœnix furnace (which belongs to Mr. Maltby). No ore has been raised since March, 1879, as sufficient stock had accumulated to last the furnace for more than a year. When visited, in September, 1880, preparations were being made to resume mining. The pit is 100 feet deep. The ore lies between slate on the north and limestone on the south. The following analyses show the character of the ore:

c

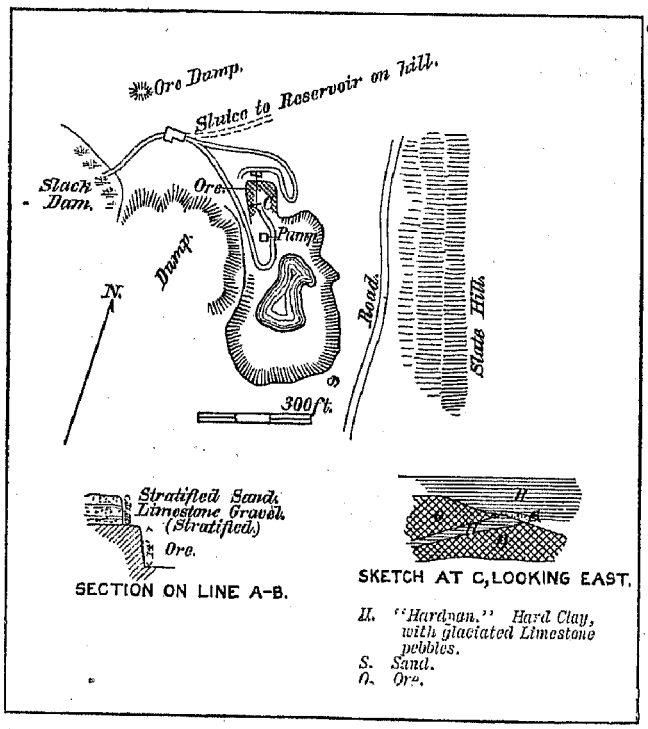

FIG. 38.—SKETCH OF THE RIGA MINE, DUTCHESS COUNTY, NEW YORK.

d

	No. 766.	No. 767.
	Per cent.	*Per cent.*
Metallic iron	41.00	48.05
Phosphorus	0.156	0.215
Phosphorus in 100 parts iron	0.380	0.447

Sample No. 766 is from 400 tons of washed ore; sample No. 767 is from 500 tons of rock-ore.

The *Riga* mine (13) lies northwest of Maltby's, near the station of Mount Riga. It is owned and worked by the Mount Riga Iron Mining Company. The mine was opened in 1865, and has produced a total of 60,900 tons of ore. In the census year 4,130 tons were mined. Nearly all the ore is washed. The loss in washing is about 50 per cent. of the material raised (exclusive of the stripping). The stripping is about 15 feet thick. It is partly a hard, blue clay, containing rounded and striated limestone pebbles. At one point a tongue of this clay has been forced in under the ore (see sketch, Fig. 38). A sample from a pile of 600 tons of washed ore contained—

e

f

	No. 768.
	Per cent.
Metallic iron	41.58
Phosphorus	0.611
Phosphorus in 100 parts iron	1.470

A second determination of the phosphorus was made, but with practically the same result.

The *Dakin* mine (14) is 1½ miles north of Mount Riga. It was opened in 1872, but was idle in 1879, and although work was resumed in the spring of 1880, no ore was raised before the close of the census year. The mine is worked under lease by the Dakin Brothers. The pit is small. The ore mined during the summer of 1880 was sent principally to Hudson, and a sample was taken there from the stock-pile. The sample contained—

	No. 1101.
	Per cent.
Metallic iron	40.55
Phosphorus	0.357
Phosphorus in 100 parts iron	0.885

a

The Dakin completes the list of active mines in Dutchess county.

COLUMBIA COUNTY.

The *Reynolds* mine (15) is in Ancram township, near the Poughkeepsie and Eastern railroad, and was first opened in 1857. It was reopened in April, 1880, after having been idle for five years. The mine is owned by James Hendrick, and is worked under lease by George Williams & Co. In the census year 2,543 tons of ore were produced. The ore is mostly used in anthracite furnaces mixed with magnetite. A sample from 50 tons of washed ore at the mine contained—

b

	No. 769.
	Per cent.
Metallic iron	40.61
Phosphorus	0.056
Phosphorus in 100 parts iron	0.138

c

The ore is covered with 8 to 10 feet of sand and gravel. The pit is about 40 feet deep.

The *Weed* mine (16) is located about 1 mile north of Boston Corners. It was opened in 1780, and has yielded, it is estimated, 168,000 tons of ore. The mine is owned by the Weed Ore Company, from whom it is leased by George Williams. The ore is used in the local charcoal furnaces and on the Hudson river. In the census year 11,200 tons were produced. The ore appears to lie wholly in slate, to which it conforms in dip. The deposit is far more regular than is usual with the beds of limonite in this region. A sample of the ore from the stock-pile at Hudson contained—

	No. 1102.
	Per cent.
Metallic iron	40.21
Phosphorus	0.083
Phosphorus in 100 parts iron	0.206

d

The *Copake* mine (17) is situated near Copake furnace. It is owned and operated by Frederick Miles, the owner of the furnace. The mine is an old one. In the census year it produced 4,480 tons of ore. When visited no ore was being raised, and an average sample was difficult to collect. A sample from about 20 tons of a mixture of rock and washed ore contained—

	No. 770.
	Per cent.
Metallic iron	40.70
Phosphorus	0.424
Phosphorus in 100 parts iron	0.906

e

A sample from a pile of 75 tons of "dead head" (carbonate of iron) yielded—

	No. 771.
	Per cent.
Metallic iron	30.82
Phosphorus	0.248
Phosphorus in 100 parts iron	0.805

f

The *Hillsdale*, *Mitchell*, and *Haight* mines, all in Hillsdale township, which adjoins Copake on the north, were not worked in the census year, and were not sampled.

III. Carbonate ore.

a Carbonate ore was discovered six or seven years ago near the Hudson river, in Greenport and Germantown townships, Columbia county. Several open cuts have been made on the deposit, and a number of thousands of tons of ore have been mined. No ore was raised in the census year, however, and the mines were not visited. They were briefly described by R. W. Raymond in Vol. IV *Trans. Am. Inst. Min. Eng.*, p. 339. A sample was collected from a pile of 1,000 tons of the ore at the Hudson Iron Company's furnace, and contained—

	No. 1103.
	Per cent.
Metallic iron	41.41
Phosphorus	0.159
b Phosphorus in 100 parts iron	0.384

The ore represented by the sample was partially peroxidized. The mines are owned by the Columbia Spathic Ore Company.

With the exception of the above there are no mines of the carbonate of iron in the state.

IV. Fossil ore.

c The Clinton group of the Upper Silurian formation, containing the fossil ore, forms a narrow but unbroken belt which "sweeps along the hills south of the Mohawk valley westward past Syracuse, Rochester, and Niagara toward Detroit". Oxide of iron occurs at about the same horizon throughout the extent of this belt as far west, at least, as the Genesee river, but probably it is not always in workable thickness. It is to-day actually mined only in parts of Oneida and of Wayne counties. In Oneida county the ore was not mined in the census year east of Utica. West of Utica beds were worked in New Hartford, Kirkland, Westmoreland, and Verona townships. No ore has recently been mined between the town of Verona, in Oneida county, and the town of Sterling, in Cayuga county, but Mr. Vanuxem (*a*) observed it at several localities in Madison county. A bed was opened near the town of Sterling, near the western town (and county) line, and immediately north of the Lake Shore division of the Rome, Watertown and Ogdensburgh railroad, in 1874. But little ore was dug, however, and the mine has been idle for d several years. A few miles west of the above, in the town of Walcott, Wayne county, ore was dug many years ago for the old Walcott furnace. This bed, too, is now idle. In the town of Ontario, Wayne county, ore has been dug for many years, and, so far as is now known, this is the western limit of the bed of workable ore in the state.

ONEIDA COUNTY.

In Oneida county there are, according to Mr. Vanuxem, (*b*) two beds of ore separated by about 20 feet of greenish-blue shales, with thin layers of the same colored sandstone, containing fucoids. The lower ore-bed rests upon a thin sheet of sandstone, below which there are 35 to 40 feet of shale, then a thick bed of sandstone, quarried in many localities for building-stone, and then another series of shales resting upon the Oneida conglomerate. The members of the Clinton group vary greatly, however, in their lithological character with their geographical position. e Associated with the upper ore stratum is a mixture of limestone, shale, etc. The upper bed is thicker than the lower one, but the ore is said to be less pure.

At no point visited by the writer were the two beds worked near each other, and the horizon of the different openings was not fully determined. But from Mr. Vanuxem's descriptions it is believed that the ore sampled in New Hartford, Kirkland, and Westmoreland townships was principally, if not entirely, mined from the lower bed, while that from Verona township came from the upper bed.

In New Hartford, Kirkland, and Westmoreland townships the ore is oölitic; it is of medium hardness, and reddens everything with which it comes in contact. In Verona township the ore is harder and is not oölitic. It resembles the "hard fossil" ore of the Juniata valley, Pennsylvania. The earthy material found near the outcrop of the fossil ore in Pennsylvania, and there known as "soft fossil", occurs only in small quantities. The ore-bed dips toward the southwest at an angle equivalent to a fall of about 1 foot in a hundred. Excepting near Clinton f the ore is exploited only by stripping and quarrying.

Davis' ore-bed (1) (*c*) is situated in the town of New Hartford, about 1 mile east of Washington mills. The outcrop has been worked on three sides of the hill. A section on the north side of the hill, where ore was being dug when the locality was visited, shows 15 inches of a soft, rich-looking oölitic ore, covered with 9 feet of olive

a Geology Third District, p. 88. *b Geology Third District*, p. 84. c See map, Fig. 39.

shale, and 3½ feet of soil and gravel. The greater part of the shale is soft and can be removed with the pick, but a that immediately over the ore requires blasting. The ore-bed dips into the hill so that the stripping will increase as the breast advances. A sample from a few tons of the ore yielded, on analysis—

	No. 1323.
	Per cent.
Metallic iron	43.76
Phosphorus	1.116
Phosphorus in 100 parts iron	2.550

The bed is worked by J. G. Egbert. In the census year 3,360 tons of ore were produced from this and the b adjoining (Norton's) farm.

West of the above bed the ore has been entirely eroded by the creek which flows northward through the middle of New Hartford township. Crossing this valley the ore horizon is again reached near the eastern town-line of Kirkland, about 4 miles distant from the Davis bed. From the town-line the ore bed has been worked almost continuously as far west as Clinton, where it has been eroded by the Oriskany creek.

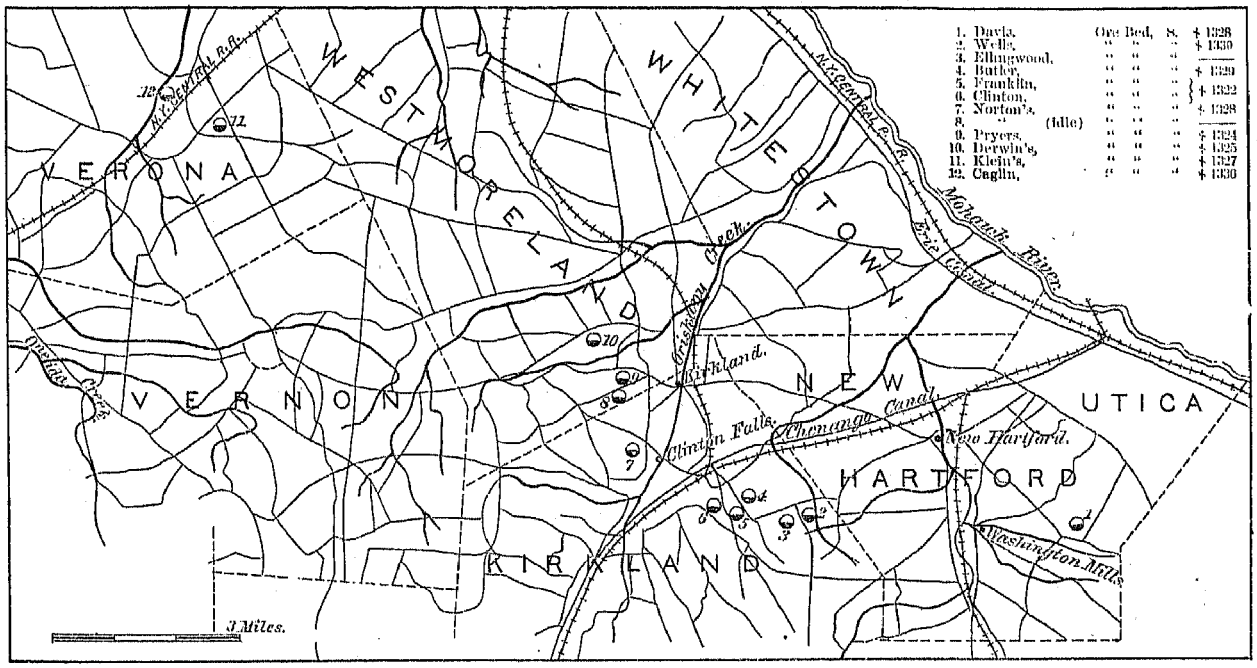

FIG. 39.—MAP OF A PORTION OF ONEIDA COUNTY, NEW YORK, SHOWING POSITION OF FOSSIL ORE MINES.

At the *Wells* bed (2) there is almost 21 inches of ore covered with 8 to 10 feet of shale and 4 to 8 feet of gravel e and soil. The bed is worked by the Franklin Iron Company. A sample of the ore from a pile of 400 tons contained—

	No. 1330.
	Per cent.
Metallic iron	46.79
Phosphorus	0.640
Phosphorus in 100 parts iron	1.368

The Ellingwood farm lies west of the Wells. No ore was being dug here in June, 1881. The ore was analyzed by Mr. J. B. Britton in February, 1880, for the Franklin Iron Company, with the following results: f

	Per cent.		*Per cent.*
Alumina	3.98	Undetermined matter and loss	0.443
Lime	6.66	Metallic iron	41.05
Magnesia	2.17	Oxygen with the iron	17.15
Silica	10.14	Total	100.000
Water and carbonic acid	15.14		
Phosphoric acid	2.557	Phosphorus	1.117
Sulphur	0.51	Phosphorus in 100 parts iron	2.721
Oxide of manganese	0.20		

a A short distance west of the Ellingwood farm the line of outcrop of the ore bed bends sharply to the northward, crossing the road (see Fig. 40).

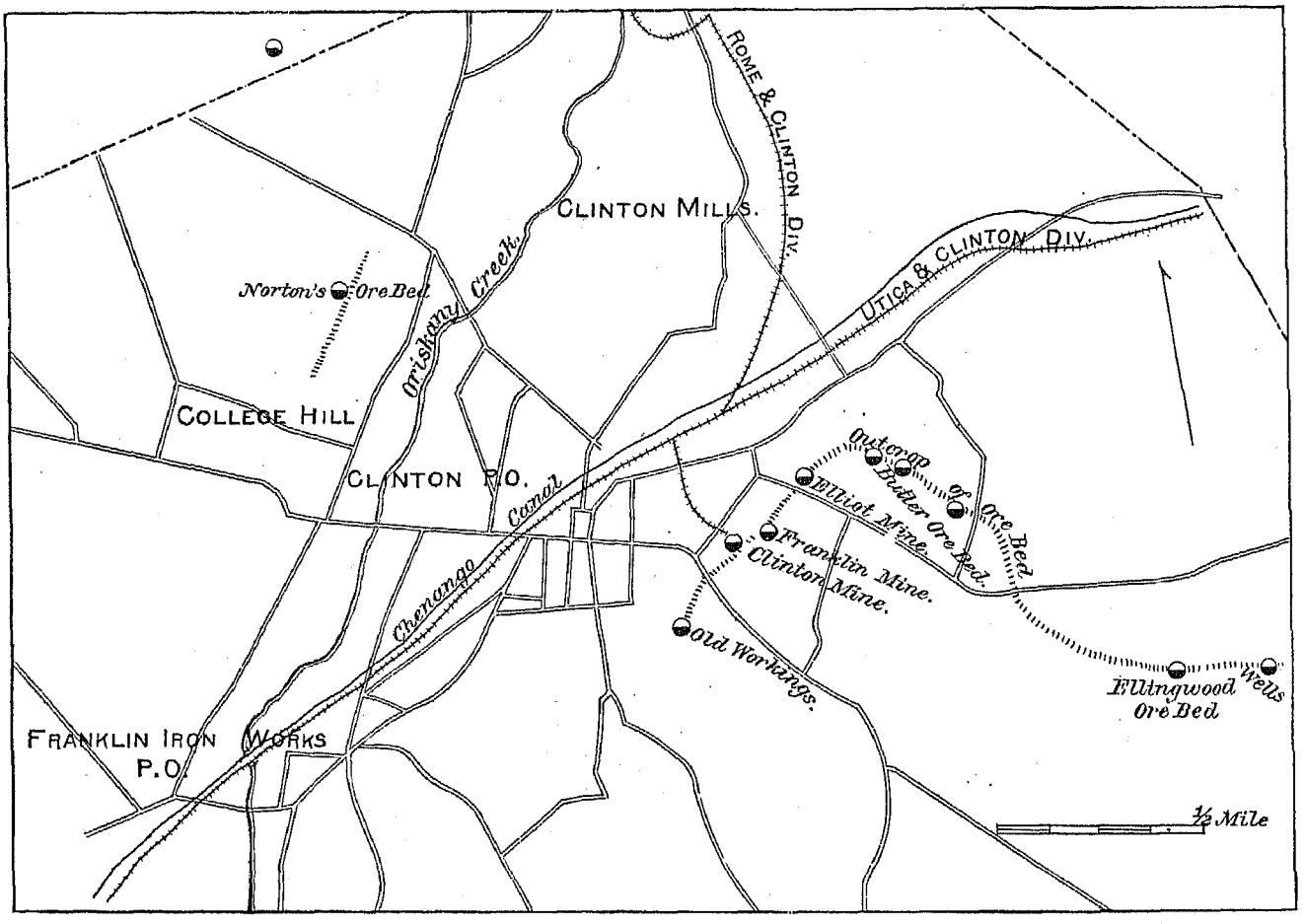

FIG. 40.—MAP SHOWING THE OUTCROP OF THE FOSSIL ORE-BED NEAR CLINTON, ONEIDA COUNTY, NEW YORK.

The *Butler* ore-bed is located north of the road. It is worked by Elliott & Bronson, and the ore is shipped to Albany and elsewhere. The ore is 23 inches thick. A sample contained—

	No. 1320.
	Per cent.
Metallic iron	45.73
Phosphorus	0.554
Phosphorus in 100 parts iron	1.211

West of the Butler bed the outcrop takes a southwesterly direction along the eastern side of the Oriskany valley. Here all the ore that it would pay to mine by stripping has been removed, and underground mining is being resorted to.

At the *Franklin* and *Clinton* mines (owned and operated by the Franklin Iron Company) the ore has a total thickness of about 25 inches. It lies in two "tiers". The under "tier" is 8 inches, and the upper one 16 to 17 inches thick. The "tiers" are separated by 12 to 15 inches of shale. Above and below the ore there is usually a few inches of ferruginous sandstone—the top and bottom rocks of the miners. This rests upon, or is covered with, green shales. The ore will average, it is said, 2 tons to the square yard. The long-wall system of mining is employed. The rock from the roof, which it is necessary to take down that the men may have room to work, is "gobbed" up behind the miners as the wall advances, and is sufficient in general to support the roof. A little timbering is used along the gangways only.

The ore is all shipped by rail to the Franklin Iron Works. The following analysis is of a sample from a pile of 2,300 tons of ore at the furnace, and represents the output from the two mines:

	No. 1322.
	Per cent.
Metallic iron	44.22
Phosphorus	0.710
Phosphorus in 100 parts iron	1.606

The following analyses of this ore made for the Franklin Iron Company are here inserted by permission: a

	No. 1.	No. 2.	No. 3.	No. 4.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Peroxide of iron	63.00	79.98	71.82	42.97
Protoxide of manganese	0.15	Trace.	1.63	0.37
Alumina	5.45	2.40	3.91	4.13
Lime	6.20	1.54	3.97	8.57
Magnesia	2.77	0.30	2.21	1.06
Silica	12.03	9.08	0.31	0.31
Carbonic acid	0.15	} 4.30	2.47	0.47
Water	2.77			
Phosphoric acid	1.70	1.230	2.066	1.534
Sulphur	0.23	None.	None.	0.837
Insoluble silicious matter	.....	.....	11.03	20.41
Undetermined matter and loss	.....	0.171	0.554	0.439
Total	100.85	100.00	100.00	100.00
Metallic iron	44.10	56.37	50.08	30.08
Phosphorus	0.65	0.541	0.915	0.670
Phosphorus in 100 parts iron	1.474	0.959	1.805	2.227

b

No. 1 is an average of a pile of ore from the Franklin and Clinton mines, and was made by *Prof. A. H. Chester*, March 20, 1873. The other three analyses are by J. B. Britton, and were made in the spring of 1880. No. 2 is of c a sample of ore from the Franklin mine; No. 3, a sample from the Clinton mine; and No. 4, a sample from the bottom tier in the Franklin mine.

The *Elliott* mine, northeast of the Franklin, is worked by Elliott & Bronson. In the census year Elliott & Bronson raised 11,380 tons of ore. The Franklin Iron Company's mines produced 16,420 tons of ore the same year.

On the west side of the Oriskany valley ore is being dug on Norton's farm, near Clinton mills. The bed is about 21 inches thick. The hill rises rapidly from the present workings, and underground mining will soon have to be resorted to or the bed abandoned. At the present breast the ore is covered with 6 feet of hard shale and 15½ feet of soft shale, gravel, and soil. The ore is soft and apparently rich.

A sample from a pile of 30 tons contained—

d

	No. 1328.
	Per cent.
Metallic iron	39.88
Phosphorus	0.605
Phosphorus in 100 parts iron	1.608

Northward of Clinton mills, and about a mile west of the Kirkland furnace, in Westmoreland township, ore has been dug on the Laughlin and Pryer farms by the Kirkland Iron Company. When visited in June, 1881, the work was confined to the *Pryer* bed (9). The bed is 18 inches thick, and will average a ton and a quarter of ore to the square yard. A sample taken at the stock-pile at the furnace contained—

e

	No. 1324.
	Per cent.
Metallic iron	42.90
Phosphorus	0.753
Phosphorus in 100 parts iron	1.755

At the present breast there is no hard shale above the ore, but the latter is covered with 14 feet of clay, gravel, and soil.

Three-quarters of a mile northwest of Pryer's farm, and on the north side of a ravine formed by a tributary to the Oriskany creek, is a comparatively small and isolated patch of ore which has been opened upon on Derwin's f farm (10). Previous to the present summer (1881) no ore had been dug here for several years. Work was resumed on June 1 by Mr. Norton. The ore is about 16 inches thick, but it is more or less mixed with silicious matter, and probably not more than two-thirds of it is fit for market. A sample from a pile of about 100 tons of sorted ore contained—

	No. 1325.
	Per cent.
Metallic iron	40.40
Phosphorus	0.693
Phosphorus in 100 parts iron	1.715

a Verona post-office is about 9 miles west of Kirkland. Ore is being dug at two localities near the village.

John Klein's ore-bed (11) is within the village limits. The ore is only 10 or 12 inches thick. It is covered with not more than 6 feet of stripping. The ore is very full of fossils, but it is not oölitic, and it differs from the Westmoreland and Kirkland ore in being much harder and in not staining the fingers on handling. About 250 tons of ore were shipped in the census year. A sample from a few tons contained—

b

	No. 1327.
	Per cent.
Metallic iron	21.85
Phosphorus	0.248
Phosphorus in 100 parts iron	1.135

On *Caylin's* farm (12), west of the New York Central railroad, and about 1 mile from Verona post-office, the ore lies near the surface, and lumps of it are found in the soil. The property has recently been leased to the Onondaga Iron Company. The ore lies underneath a swamp, and much trouble has been experienced from the water. But little ore has been raised. The bed is 15 to 17 inches thick. The ore resembles the Klein ore. A sample from a pile of about 100 tons contained—

c

	No. 1326.
	Per cent.
Metallic iron	40.27
Phosphorus	0.328
Phosphorus in 100 parts iron	0.815

WAYNE COUNTY.

The ore-bed worked in Ontario township is, according to Professor Hall, (*a*) the lower bed. Professor Hall gives the following section on the Genesee river: Upper limestone, 18 feet 4 inches; upper green shale, 24 feet; pentamerus limestone, 14 feet; iron-ore bed, 14 inches; lower green shale, 23 feet.

d The place for the upper bed of iron ore is below the upper limestone. It is wanting in this section, and was not identified west of Sodus point, in the north central part of Wayne county.

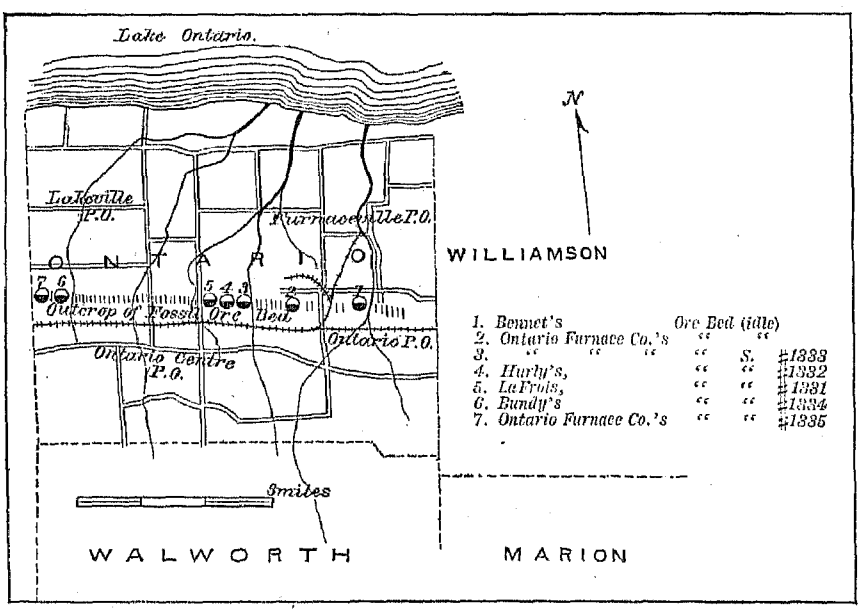

FIG. 41.—MAP SHOWING THE OUTCROP OF THE FOSSIL ORE-BED IN ONTARIO TOWNSHIP, WAYNE COUNTY, NEW YORK.

In Ontario township the ore-bed dips southward at the rate of about 15 inches in the hundred feet. Its outcrop extends in an east and west direction, and has been opened upon in an almost continuous e line across the town, exposing a breast of ore 5 to 6 miles long and 15 to 20 inches thick. The ore is exploited by stripping and quarrying. At present 12 to 15 feet is considered the limit in the thickness of stripping, beyond which it does not pay to work. Before this limit is reached a width of several hundred feet of ore may often be removed. No underground mining has been attempted. The surface f material removed from the ore preparatory to quarrying is chiefly drift and partially decomposed shale.

The location of the "beds" worked in June, 1881, is shown on the map, Fig. 41.

In the census year a total of 48,389 tons of ore was shipped from this town.

Bennett's bed (1), the easternmost one recently worked, is now idle; 6,720 tons of ore were dug here in the census year.

West of Bennett's farm the Ontario Furnace Company have a long line of workings. At (3) the ore is 20 inches thick. It is represented by sample No. 1333.

West of the above Hurly Brothers have recently begun digging ore. At (4) the bed is 20 inches thick. The character of the ore is shown by sample No. 1332.

---

a Geology Fourth District, pp. 61, 67.

Adjoining Hurly's on the west J. La Frois is working a bed (5). Sample No. 1331 is from a pile of 150 tons of the ore. The bed is 20½ inches thick.

Bundy's ore-bed (6) is about 2 miles west of La Frois'. The ore is 14 inches thick, and will run 1 to 1¼ tons to the square yard. Sample No. 1334 was taken from a pile of 30 tons of the ore.

The Ontario Furnace Company is working a bed (7) west of Bundy's, and not far from the western town-line. The ore is 18 to 20 inches thick.

The analyses of the foregoing samples resulted as follows:

	No. 1333.	No. 1332.	No. 1331.	No. 1334.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Metallic iron	41.46	40.73	42.25	38.36
Phosphorus	0.578	0.531	0.481	0.471
Phosphorus in 100 parts iron	1.394	1.304	1.138	1.254

The ore resembles that mined near Clinton, Oneida county, with the exception that it is usually in larger grains which are more or less flattened.

V. Hematite.

The mines of hematite at present worked in the state occupy a single belt which extends from the town of Philadelphia, in Jefferson county, in a northeasterly direction to the town of Gouverneur, in Saint Lawrence county.

The mines recently in operation are the Shirtleff, Dickson, Old Sterling, and Keene, in Jefferson county, and Caledonia and Kearney, in Saint Lawrence county (see map, Fig. 42).

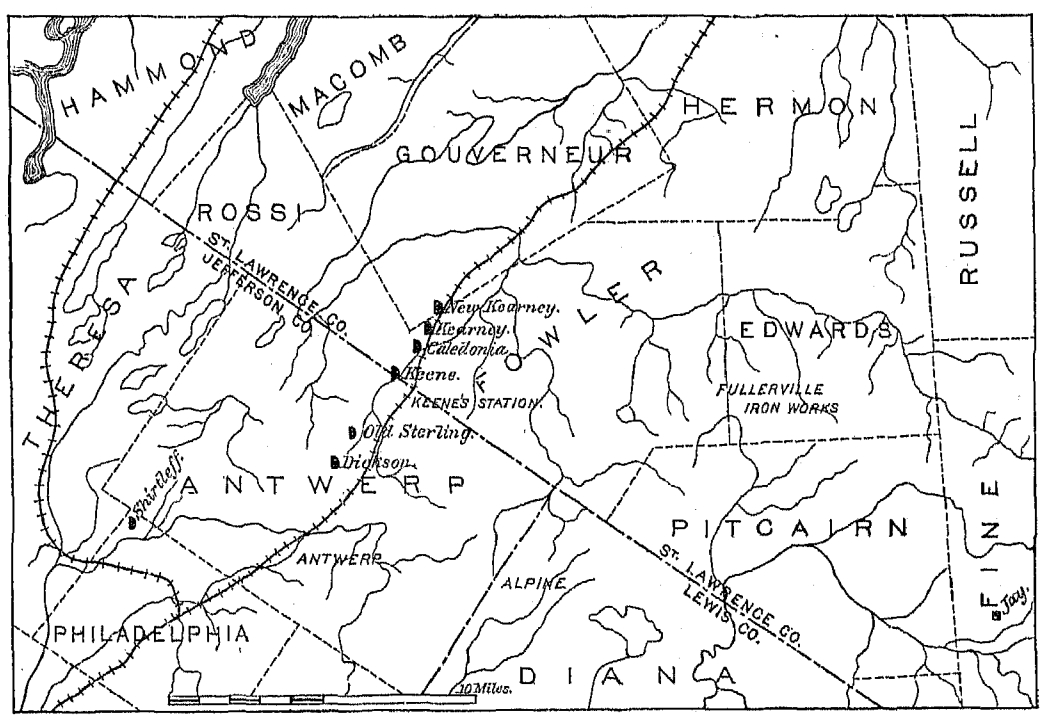

FIG. 42.—MAP SHOWING THE LOCATION OF THE HEMATITE ORE-MINES IN JEFFERSON AND SAINT LAWRENCE COUNTIES, NEW YORK.

From these six mines there was produced in the census year 94,510 tons of ore.

With the exception of the Dickson and the Keene, the above-named mines have been worked for many years, and were described by Dr. Emmons in his *Report on the Geology of the Second District*. Several localities mentioned by Dr. Emmons are no longer worked. Among these are the Tate and Polley mines in Hermon township, Saint Lawrence county, northeast of Gouverneur. Ore has recently been discovered in Macomb township, near Black lake, but the property has not yet been developed.

The ore from the several mines sampled is much the same in general appearance, consisting of an amorphous red powder or mass, in which are imbedded various sized lumps or concretions of hard specular ore. The latter is close-grained, and has a steely luster; it is very hard. Specimens were obtained in which the ore has a mammillary structure, and scales of micaceous specular ore were occasionally observed. The amorphous mass has an unctuous feel and strongly soils whatever comes in contact with it. Its color differs slightly in the different mines, so that the ores can usually be distinguished.

a The ore-formation is made up of the ore above described and a silicious-magnesian rock. The silicious material is usually a very compact, brownish sandstone or quartzite; but sometimes masses of white quartz occur. The magnesian rock is greenish, unless discolored by the iron ore, and resembles the rock underlying the ore-formation, except that the latter is often schistose, while the former is usually massive. It is called serpentine by Emmons. The silicious and magnesian rocks are so associated in the ore-formation as to suggest to Emmons the idea of a breccia, and the mass is by him called a "serpentine breccia", although he says, that "usually the quartz is so perfectly incorporated with it [the serpentine] that it appears to be contemporaneous in origin".(*a*) The ore lies in irregular-shaped masses or pockets, in this "quartzose-serpentine". Carbonate of iron, carbonate of lime, pyrite, and other minerals have been found associated with the ore.

b The geological position and relations of the ore-formation have been variously stated. Emmons considered the ore with its associated "serpentine" to have been erupted after the deposition of the Potsdam sandstone, while Vanuxem, from facts observed in the Third district, suggested that the ore had been deposited, associated with a calcareous marl, on the primary surface previous to or during the first deposits of the sandstone.

More recently Brooks,(*b*) from facts observed in the Caledonia and Keene mines, concludes that there, at least, the iron-ore formation is of Lower Silurian age. He worked out a stratigraphical series of six members, the Potsdam sandstone forming the top of the series and the iron-ore formation coming immediately under the sandstone. The third member is the magnesian rock, or serpentine, which forms the foot-wall of the mines; the fourth is a crystalline limestone; the fifth, a sandstone similar in character to No. 1; the sixth, a limestone closely resembling No. 4, but differing in containing in places irregular beds or veins of granite. Underlying this series, which Brooks considers to have a minimum thickness of about 700 feet, is the Laurentian gneiss, forming a part of the great c Archæan area of northern New York.

At the *Shirtleff* mine, in Philadelphia township, the ore is described by Emmons (*c*) as lying in the "primary rock". But so far as I could learn, gneiss has never been uncovered in the pit, and no outcrop of it was observed within several hundred feet of the ore. Sandstone caps the low ridge east of the pit, and it originally partially covered the ore; but whether conformably or not, I believe has not yet been determined. In the pit itself, both walls are "quartzose-serpentine". The workings consist of an open cut about 1,300 feet in length, from which all the ore has been removed, and the underground extension of the open cut to the southwest, where mining operations are now being carried on. The underground portion of the mine at the "100-foot level" is about 500 feet long. The ore-bed has been worked, therefore, for a continuous length of about 1,800 feet. The entire workings are nearly straight and have a direction of north 65° east. The dip is about 45° to the northwest. The stope, which d is at the extreme southern end of the mine, is about 20 feet wide, but the proportion of rock is larger than usual and probably less than one-half of the material raised from the pit can be shipped. To what depth the open pit was worked cannot now be seen, as the pit has been partly filled with rock. From the northeast end of the underground mine a shaft has recently been sunk to the "200-foot level", and drifts have been started from it.

The mine is owned and operated by the Sterling Iron Company. In the census year it produced 18,990 tons of ore. A sample from 25 tons of cobbed ore ready for shipment contained—

e

	No. 1344.
	Per cent.
Metallic iron	40.40
Phosphorus	0.204
Phosphorus in 100 parts iron	0.500

The *Dickson* mine, in Antwerp township, about 2 miles north of the village of Antwerp, was opened about two years ago. The ore-mass is not quite so regular as at the Shirtleff mine; its direction and dip are, however, about the same. The pit is 70 feet deep, and is worked entirely open to day. The mine is owned and worked by the Jefferson Iron Company. It produced 8,834 tons of ore in the census year. A sample from several car-loads of ore contained—

f

	No. 1342.
	Per cent.
Metallic iron	46.32
Phosphorus	0.285
Phosphorus in 100 parts iron	0.615

The *Old Sterling* mine, also operated by the Jefferson Iron Company, is located about 1 mile northeast of the Dickson. A pit has been opened between the two mines, but it is now idle. The Sterling mine consists of an open pit

a Geology Second District, p. 96.

b On certain Lower Silurian rocks in Saint Lawrence county, New York, which are probably older than the Potsdam sandstone. *American Journal*, III, iv, p. 22.

c Loc. cit., p. 376, under "Iron ores of Theresa".

about 400 feet long, 175 feet wide, and, at the south end, 120 feet deep. The direction of the longest axis of the pit a
is north 25° east. The ore dips to the west and *pitches* to the south. There is a ridge of gneiss a few hundred feet east of the pit, but that rock has nowhere been uncovered in the mine. The present workings are at the southern end of the pit, where a wide drift has been driven southward underneath a roof of lean ore, and on the western side where a pocket or chamber of ore is being excavated. Mr. Emmons observed in the ore from this mine a golden-yellow mineral, which he says resembles *kakoxene* (a phosphate of iron). A sample of the ore from the cars contained—

	No. 1343.
	Per cent.
Metallic iron	41.92
Phosphorus	0.130
Phosphorus in 100 parts iron	0.310

b

In the census year the mine produced 21,196 tons of ore.

The *Keene* mine is situated west of Keene station, and near the boundary-line between Jefferson and Saint Lawrence counties. It is reported on the census schedules to be in Jefferson county, but Major Brooks refers to it as in Saint Lawrence county. The ore here lies quite flat and is covered with sandstone, which forms, in part, the roof of the mine. The workings are all underground, and are entered through a horizontal drift driven westward underneath the sandstone, which latter, at the mouth of the drift, forms a bluff 20 feet or more in height. Bending a little to the southward after entering, the old workings extend through the hill nearly on a level. But north of c
the entrance the ore pitches downward, the formation exhibiting at the same time numerous rolls. The floor of the mine and the immediate roof of the deeper portions is the "quartzose-serpentine" rock, resembling that occurring in the mines already mentioned. Near the entrance good ore occurred close to the sandstone, which latter is there seen to be very ferruginous.

A sample of the ore from three car-loads at the mine contained—

	No. 1341.
	Per cent.
Metallic iron	42.18
Phosphorus	1.138
Phosphorus in 100 parts iron	2.698

d

The mine is operated by the Rossie Iron Works. Fifteen thousand three hundred and ninety tons of ore were raised from it in the census year.

The *Caledonia* mine, also operated by the Rossie Iron Works, is located 1 mile northeast of the Keene. The principal workings are now near the road, and are on what appears to be an anticlinal pitching southward. The ore dips to the south, southeast, and southwest. The main mine is south of the opening, and the average dip in this direction is about 30°. Sandstone covers the ore-formation at nearly all points, but it forms the actual roof of the mine in but few places. The southern end of the workings is over 150 feet below the surface. A vertical diamond-drill hole from the bottom of the mine near the pump-shaft passed through the "serpentine" floor, then through a second bed of ore, and finally into crystalline limestone. The hole terminated in the latter. I was e
told that a layer of an extremely hard substance was encountered in this hole which rapidly wore away the diamonds of the drill. Specimens of the core were sent to New York to be examined, and were there pronounced to be a good quality of corundum. I did not see any of these cores myself.

Northeast of this pit is a low ridge capped with sandstone where the first ore was mined on the property. These workings, now abandoned, were figured by Emmons as the Parish mine.

East of the north end of this ridge is the Dillman shaft, from which ore is now being raised. The pit is some 125 feet deep and 100 feet long. The ore dips toward the east at about 45°. Drifts driven north and south from either end of the pit are in rock, but immediately under the skiproad the ore is 10 to 12 feet thick.

The samples of ore collected at this mine contained—

	No. 1338.	No. 1339.	No. 1340.
	Per cent.	*Per cent.*	*Per cent.*
Metallic iron	48.30	36.78	54.16
Phosphorus	0.115	0.212	0.156
Phosphorus in 100 parts iron	0.238	0.576	0.288

f

Sample No. 1338 is from a pillar at the bottom of Dillman's shaft; sample No. 1339 represents ore from that part of the main mine known as Fox's pit, and sample No. 1340, ore from that part of the main mine known as Shatreau's pit. The samples were taken from the cars. Fox's pit is near the surface.

In the census year the Caledonia mine produced 21,439 tons of ore.

a At the *Kearney* mine, northeast of the Caledonia, there is an oval-shaped pit 200 feet long, 140 feet wide at the surface, and about 70 feet deep. At the bottom the pit is only 30 to 40 feet wide. The ore dips eastward under the sandstone, which has been partly removed in order to permit the mine to be worked open to day. The mine is owned by Pope, Wheelock & Co., and worked by John Webb, jr., & Co. In the census year 8,960 tons of ore were produced. The ore is represented by sample No. 1337, collected from a pile of 4,000 tons.

About one-quarter of a mile northeast of the Kearney mine Messrs. Webb & Co. have recently begun opening a pit, which they call the *Little Kearney* mine. A slope has been driven northward under the sandstone to a depth of 50 feet, at an angle of 45°. At the bottom of the slope the ore is said to be 12 feet thick. The pit was temporarily idle when visited, and was partly filled with water. A sample of the ore was collected from a few tons near the **b** slope, and is represented by No. 1336. The samples contained—

	No. 1337.	No. 1336.
	Per cent.	*Per cent.*
Metallic iron	46.46	44.35
Phosphorus	0.214	0.226
Phosphorus in 100 parts iron	0.461	0.509